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ANNUAL REPORT

20383

OF THE

# BOARD OF REGENTS

OF THE

SMITHSONIAN INSTITUTION,

SHOWING

THE OPERATIONS, EXPENDITURES, AND CONDITION  
OF THE INSTITUTION

FOR

THE YEAR 1881.



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WASHINGTON:  
GOVERNMENT PRINTING OFFICE.  
1883.

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IN THE SENATE OF THE UNITED STATES,

June 20, 1882.

The following resolution was agreed to by the Senate May 16, 1882, and concurred in by the House of Representatives June 20, 1882:

*Resolved by the Senate (the House of Representatives concurring),* That fifteen thousand five hundred and sixty copies of the Report of the Smithsonian Institution for the year 1881 be printed; two thousand five hundred copies of which shall be for the use of the Senate, six thousand and sixty copies for the use of the House of Representatives, and seven thousand copies for the use of the Smithsonian Institution.

Attest:

FRANCIS E. SHOBER,  
*Acting Secretary.*

LETTER

FROM THE

SECRETARY OF THE SMITHSONIAN INSTITUTION,

ACCOMPANYING

*The annual report of the Board of Regents of that Institution for the year  
1881.*

---

MAY 16, 1882.—Ordered to be printed.

---

SMITHSONIAN INSTITUTION,  
*Washington, March 1, 1882.*

GENTLEMEN: In behalf of the Board of Regents, I have the honor to submit to the Congress of the United States the annual report of the operations, expenditures, and condition of the Smithsonian Institution for the year 1881.

I have the honor to be, very respectfully, your obedient servant,

SPENCER F. BAIRD,

*Secretary Smithsonian Institution.*

Hon. DAVID DAVIS,

*President of the United States Senate, and*

Hon. J. WARREN KEIFER,

*Speaker of the House of Representatives.*

III

20302

# ANNUAL REPORT OF THE SMITHSONIAN INSTITUTION FOR THE YEAR 1881.

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## SUBJECTS.

1. Proceedings of the Board of Regents for the session of January, 1882.
2. Annual report of the Secretary, giving an account of the operations and condition of the Institution for the year 1881, with the statistics of collections, exchanges, &c.
3. Report of the Executive Committee, exhibiting the financial affairs of the Institution, including a statement of the Smithsonian fund, the receipts and expenditures for the year 1881, and the estimates for 1882.
4. General appendix, comprising a record of recent progress in the principal departments of science, and special memoirs, original and selected, of interest to collaborators and correspondents of the Institution, teachers, and others engaged in the promotion of knowledge.



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## REGENTS OF THE SMITHSONIAN INSTITUTION.

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By the organizing act approved August 10, 1846, Revised Statutes, title lxxiii, section 5580, "The business of the Institution shall be conducted at the city of Washington by a Board of Regents, named the Regents of the Smithsonian Institution, to be composed of the Vice-President, the Chief Justice of the United States, [and the Governor of the District of Columbia,] three members of the Senate, and three members of the House of Representatives, together with six other persons, other than members of Congress, two of whom shall be resident in the city of Washington, and the other four shall be inhabitants of some State, but no two of them of the same State."

---

### REGENTS FOR THE YEAR 1881.

Term expires.

#### The Vice-President:

WILLIAM A. WHEELER.....	Mar. 4, 1881
CHESTER A. ARTHUR (became President) .....	Sept. 19, 1881
DAVID DAVIS ( <i>pro tem.</i> ).....	Mar. 4, 1883

#### The Chief Justice, MORRISON R. WAITE.

#### United States Senators:

GEORGE F. HOAR (from Feb. 21, 1881).....	Mar. 4, 1883
NATHANIEL P. HILL (from May 19, 1881) .....	Mar. 4, 1885
SAMUEL B. MAXEY (from May 19, 1881) .....	Mar. 4, 1887

#### Members of the House of Representatives:

HIESTER CLYMER .....	Dec. 28, 1881
JAMES A. GARFIELD .....	Dec. 28, 1881
JOSEPH E. JOHNSTON.....	Dec. 28, 1881

#### Citizens of Washington:

PETER PARKER (appointed in 1868) .....	Dec. 19, 1885
WILLIAM T. SHERMAN (appointed in 1871) .....	Mar. 25, 1885

#### Citizens of a State:

JOHN MACLEAN, of New Jersey (appointed in 1868).....	Dec. 19, 1885
ASA GRAY, of Massachusetts (appointed in 1874) .....	Dec. 19, 1885
HENRY COPPÉE, of Pennsylvania (appointed in 1874).....	Dec. 19, 1885
NOAH PORTER, of Connecticut (appointed in 1878).....	Jan. 26, 1884

MORRISON R. WAITE, Chancellor of the Institution and *President of the Board of Regents.*

## JOURNAL OF PROCEEDINGS OF THE BOARD OF REGENTS OF THE SMITHSONIAN INSTITUTION.

---

WASHINGTON, D. C., *January 18, 1882.*

The annual meeting of the Board of Regents of the Smithsonian Institution was held this day at 10 o'clock a. m., in the Regent's room.

Present: The Chancellor—Chief Justice Waite, Hon. Geo. F. Hoar, Hon. N. P. Hill, Hon. S. B. Maxey, Hon. N. C. Deering, Hon. E. B. Taylor, Hon. S. S. Cox, Rev. Dr. John Maclean, Hon. Peter Parker, Dr. Asa Gray, Dr. Henry Coppée, General Wm. T. Sherman, Dr. Noah Porter, and the Secretary, Prof. S. F. Baird.

The Chancellor made the following announcement relative to the appointment of members of the Board:

On the 21st of February, 1881, the Vice-President (Mr. WHEELER) appointed Hon. G. F. HOAR as Regent, vice Hon. H. Hamlin, resigned.

On the 19th of May, 1881, the Vice-President (Mr. ARTHUR) appointed Hon. S. B. MAXEY, of Texas, and Hon. N. P. HILL, of Colorado, Regents, vice Hon. R. E. Withers and Hon. N. Booth, whose terms had expired.

On the 9th of January, 1882, the Speaker of the House (Mr. Keifer) appointed as Regents for the term of the 47th Congress, Hon. N. C. DEERING, of Iowa, Hon. E. B. TAYLOR, of Ohio, and Hon. S. S. COX, of New York.

The Chancellor called the attention of the Board to the death of President GARFIELD, *ex officio* presiding officer of the Institution, and for many years one of its Regents.

On motion of Dr. Gray it was—

*Resolved*, That the Chancellor be requested to enter upon the record an expression of the sense of the great loss which the Institution has sustained by the death of one of its most devoted and distinguished administrators.

In compliance with the foregoing resolution, the Chancellor presented the following memorial notice:

General Garfield first took his seat in Congress at the end of the year 1863. He was then but thirty-six years old.

At the beginning of his second term he was appointed a member of this Board by the Speaker of the House of Representatives, and was present at the meeting of February 3, 1866. He continued to hold the

same position until 1875, when another was appointed in his place. He appeared again, however, in 1877, and we were never afterwards deprived of his counsels until he was elected President of the United States, which made him *ex officio* the presiding officer of the Smithsonian Institution.

From the beginning his presence here was felt. He was eminently fitted for such a trust.

He was himself a scholar, and the "increase and diffusion of knowledge among men" always gave him the greatest pleasure.

At every meeting of the Board during his successive terms when he could be present, his name appears among the active and thoughtful members. He manifested his appreciation of the place he filled by always doing what it was his privilege to do, and doing it well. When on former occasions the Board has given expression to its feelings upon the death of a member his words of heartfelt sympathy have often been heard. The records show that he knew and appreciated the great and good qualities of Chief Justice Chase, and that he fully realized the debt science owed to Agassiz. But the crowning act of all was when, out of the fullness of his heart, at the memorial services in the hall of the House of Representatives, he made those who heard him feel how great the life of Professor Henry had been.

It is not for us to say he ought to have been spared longer. Few men seemed to possess greater power for good. He died as he lived, an honor to human nature.

The Secretary presented an exhibit of the finances of the Institution, showing the condition of the permanent fund, the receipts and expenditures for the year 1881.

Dr. Parker presented the annual report of the Executive Committee, which was read.

On motion of Dr. Gray, it was—

*Resolved*, That the report of the Executive Committee for 1881 be accepted.

*Resolved*, That the income for the year 1882 be appropriated for the service of the Institution upon the basis of the above report, to be expended by the Secretary with full discretion as to the items, subject to the approval of the Executive Committee.

General Sherman presented the report of the National Museum Building Commission for 1881, with the report of the architects, which were read.

On motion of Dr. Coppée, it was—

*Resolved*, That the report be accepted and the Commission be discharged, with the thanks of the Board for the able and satisfactory manner in which it had discharged its duties.

On motion of Dr. Parker, it was—

*Resolved*, That, in accordance with the recommendation of the National Museum Building Commission, the thanks of the Board of Regents of

the Smithsonian Institution are hereby tendered to General M. C. MEIGS, Quartermaster-General United States Army, for his highly valued services as consulting engineer of the National Museum Building Commission, in connection with the duty with which the Commission was charged by the Board in the construction of a fire-proof building for the United States National Museum.

Dr. Gray presented the following report of the Special Committee to prepare the Henry Memorial Volume :

To the BOARD OF REGENTS :

GENTLEMEN: The Special Committee of the Board of Regents appointed to prepare for publication a volume of suitable notices and addresses commemorative of the late Professor Henry, have the honor to present the following report :

At a meeting of the Board of Regents held January 17, 1879, it was—

“ *Resolved*, That a special committee of three be appointed, of which the Secretary of the Institution shall be one, to prepare a memorial of Professor Henry, to include in a separate volume of the Smithsonian series such biographies and notices of the late Secretary of the Institution as may be considered by them worthy of preservation and publication ;” whereupon the Chancellor appointed Messrs. Gray, Parker, and Baird as the committee.

On the 6th of February, 1879, a concurrent resolution was adopted by Congress to print 15,000 copies of the Memorial Exercises in honor of Professor Henry, held in the hall of the House of Representatives on the 16th of January, 1879, in a memorial volume, together with such articles as may be furnished by the Board of Regents of the Smithsonian Institution, 7,000 copies of which were for the use of the House of Representatives, 3,000 copies for the use of the Senate, and 5,000 copies for the use of the Smithsonian Institution.

These two proceedings thus covered substantially the same ground.

In accordance with its instructions your committee has prepared a memorial volume, prefaced with a brief account of the proceedings in Congress relative to a public commemoration by services in the hall of the House of Representatives, and consisting of three parts, viz :

Part 1. The Obsequies of Joseph Henry and the proceedings connected therewith.

Part 2. The Memorial Exercises and Addresses at the Capitol, on the evening of January 16, 1879.

Part 3. A collection of proceedings by, and addresses before, some of the principal societies in this country with which Professor Henry had been connected.

An appendix of four pages contains an account of the proceedings in Congress ordering the erection of a bronze statue of the distinguished subject of our memorial.

The whole forms an octavo volume of 532 pages, which has been published as vol. 21 of the Smithsonian Miscellaneous Collections.



This work has also been published by Congress in a royal-octavo volume, and has been widely distributed during the present year.

Respectfully submitted.

ASA GRAY,  
*Chairman of the Committee.*

On motion of Dr. Maclean, it was—

*Resolved*, That the report be accepted, and the thanks of the Board tendered to the Committee for the satisfactory manner in which the duty devolved upon them had been discharged.

General Sherman, from the Executive Committee, presented the following report:

To the BOARD OF REGENTS:

GENTLEMEN: The Executive Committee, having had its attention called by the Secretary to the combustible nature and insecure condition of the eastern portion of the Smithsonian building, together with its want of adaptability to the purposes of the Institution, has decided to recommend that measures be taken to substitute fire-proof materials for the present wood and plaster partitions of the apartments.

Messrs. Cluss & Schultze, architects, have presented plans for this purpose, which, without materially changing the general architecture of the building, will provide largely increased accommodations for the offices and working rooms, the storage of publications, exchange department, &c.

The Committee, therefore, after due consideration of the subject, recommends to the Board of Regents the adoption of the following resolution:

*Resolved*, That the Secretary and Executive Committee present to Congress plans and estimates for rendering the east wing of the Smithsonian building fire-proof, to request an appropriation therefor, and, if the means are furnished, to proceed with the work.

PETER PARKER.

JOHN MACLEAN.

WILLIAM T. SHERMAN.

The resolution was unanimously adopted.

The Secretary called attention to the approaching annual meeting of the National Academy of Sciences, and requested instructions as to granting the use of a hall in the new museum for its sessions and those of similar scientific bodies.

On motion of Dr. Gray, it was—

*Resolved*, That the Secretary be authorized to provide, in the building of the National Museum, such accommodation as the National Academy of Sciences may need at its meetings in Washington, and which may be afforded without inconvenience to the establishment; also, that the

Secretary, under the sanction of the Executive Committee, may extend similar hospitality to other organizations or meetings of cognate character and importance.

General Sherman, in behalf of the Executive Committee, presented the following report:

To the BOARD OF REGENTS:

GENTLEMEN: The Board, at its last meeting, January, 1881, anticipating that the statue of Professor Henry, by Mr. Story, might be received during its recess, ordered that the site for the statue should be selected by the Executive Committee.

The artist has informed the Secretary of the Institution that the statue will be finished in January or February, and has requested him to order the pedestal according to a design he has furnished himself. This is to consist of a die of Red Beach granite, finely polished, octagonal in shape, 4 feet diameter, 4 feet high, the whole height of pedestal, with cap and bases of gray Quincy granite, to be 7 feet 3 inches.

A contract has been made with the Quincy Granite Polishing Works, at Quincy, Mass., to furnish this pedestal on the Smithsonian grounds within three months, for \$982.

At a full meeting of the Committee on Monday, January 16, 1882, after inspection of a plan of the Smithsonian grounds, and a visit to each of the sites that had been suggested as appropriate for the purpose, it was decided to make the following recommendations to the Board:

The Committee is inclined to select the triangular plot to the northwest of the Smithsonian building, the statue to face toward the south. It is deemed advisable, however, to submit this suggestion, together with a plan of the Smithsonian grounds, to the artist, Mr. Story, and to await his opinion before making a final selection of the site.

The Committee recommends that the words "JOSEPH HENRY" be placed in raised block letters on the front of the die, and on the reverse "First Secretary of the Smithsonian Institution, 1846—1878," and nothing else whatever.

In respect to the site and inscription the Committee desires that the Board should assume the responsibility of the decision.

The Committee further recommends that the Chancellor of the Institution be requested to perform the ceremony of unveiling the statue with appropriate remarks, and that an address be delivered on the occasion by Hon. Hiester Clymer.

Respectfully submitted.

PETER PARKER.

JOHN MACLEAN.

WILLIAM T. SHERMAN.

Upon a full consideration of the subject, the Regents expressed their approval of the site preferred by the Executive Committee, and, on motion of Dr. Coppée, it was—

*Resolved*, That the Executive Committee have full power as to the site and position of the statue.

In regard to the inscription, after consideration, it was, on motion of Dr. Maclean, unanimously—

*Resolved*, That the inscription on the pedestal of the statue consist of the name "Joseph Henry."

After consideration of the subject of the ceremonies to be observed at the unveiling of the statue, on motion of Dr. Porter, it was—

*Resolved*, That the Executive Committee be authorized to take such action in regard to the erection of the statue as it may think best.

The Secretary presented the annual report of the operations of the Institution for the year 1881.

On motion of Dr. Coppée, it was—

*Resolved*, That the report of the Secretary be referred to the Executive Committee, with authority to transmit it to Congress.

On motion, the Board then adjourned *sine die*.

# THE SMITHSONIAN INSTITUTION.

## MEMBERS EX OFFICIO OF THE "ESTABLISHMENT."\*

(January 1, 1882.)

**CHESTER A. ARTHUR**, President of the United States.  
**DAVID DAVIS**, President of the United States Senate.  
**MORRISON R. WAITE**, Chief Justice of the United States.  
**FREDERICK T. FRELINGHUYSEN**, Secretary of State.  
**CHARLES J. FOLGER**, Secretary of the Treasury.  
**ROBERT T. LINCOLN**, Secretary of War.  
**WILLIAM H. HUNT**, Secretary of the Navy.  
**TIMOTHY O. HOWE**, Postmaster-General.  
**SAMUEL J. KIRKWOOD**, Secretary of the Interior.  
**BENJAMIN H. BREWSTER**, Attorney-General.  
**EDGAR M. MARBLE**, Commissioner of Patents.

## REGENTS OF THE INSTITUTION.

(January 1, 1882.)

**MORRISON R. WAITE**, Chief Justice of the United States,  
*President of the Board.*  
**DAVID DAVIS**, President of the United States Senate.  
**GEORGE F. HOAR**, member of the Senate of the United States.  
**NATHANIEL P. HILL**, member of the Senate of the United States.  
**SAMUEL B. MAXEY**, member of the Senate of the United States.  
**NATHANIEL C. DEERING**, member of the House of Representatives.  
**EZRA B. TAYLOR**, member of the House of Representatives.  
**SAMUEL S. COX**, member of the House of Representatives.  
**JOHN MACLEAN**, citizen of New Jersey.  
**PETER PARKER**, citizen of Washington, D. C.  
**ASA GRAY**, citizen of Massachusetts.  
**HENRY COPPÉE**, citizen of Pennsylvania.  
**WILLIAM T. SHERMAN**, citizen of Washington, D. C.  
**NOAH PORTER**, citizen of Connecticut.

### *Executive Committee of the Board of Regents.*

**PETER PARKER.**

**JOHN MACLEAN.**

**WILLIAM T. SHERMAN.**

\* The year 1881 has been an exceptional one in the number of changes occurring in the "Establishment." The President of the United States from January 1, 1881, to March 4, was RUTHERFORD B. HAYES; from March 4 to September 19, JAMES A. GARFIELD, and from September 19 to December 31, CHESTER A. ARTHUR. The Vice-Presidents were similarly WILLIAM A. WHEELER, CHESTER A. ARTHUR, and DAVID DAVIS. The members of the Cabinet in like manner were all changed during the year.

OFFICERS AND ASSISTANTS OF THE SMITHSONIAN INSTITUTION AND NATIONAL MUSEUM, JANUARY, 1882.

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SMITHSONIAN INSTITUTION.

SPENCER F. BAIRD,  
*Secretary, Director of the Institution.*  
WILLIAM J. RHEES, *Chief Clerk.*  
DANIEL LEECH, *Corresponding Clerk.*

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NATIONAL MUSEUM.

SPENCER F. BAIRD, *Director.*  
G. BROWN GOODE, *Assistant Director, Curator, Department of Art and Industry.*  
WM. H. DALL, *Honorary Curator, Department of Conchology.*  
ROBERT RIDGWAY, *Curator, Department of Ornithology.*  
CHARLES RAU, *Curator, Department of Archæology.*  
TARLETON H. BEAN, *Curator, Department of Ichthyology.*  
HENRY C. YARROW, *Honorary Curator, Department of Herpetology.*  
CHARLES A. WHITE, *Curator, Department of Invertebrate Paleontology.*  
GEORGE W. HAWES, *Curator, Department of Geology.*  
JAMES M. FLINT, *Honorary Curator, Department of Materia Medica.*  
RICHARD RATHBUN, *Curator, Department Marine Invertebrates.*  
EDW. FOREMAN, *Assistant, Department of Ethnography.*  
FRED. W. TRUE, *Curator, Department of Mammals, and Librarian.*  
FRED. W. TAYLOR, *Chemist.*  
GEO. P. MERRILL, *Aid, Department of Mineralogy.*  
WM. S. YEATES, *Aid, Department of Mineralogy.*

# REPORT OF PROFESSOR BAIRD,

SECRETARY OF THE SMITHSONIAN INSTITUTION. FOR 1881.

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*To the Board of Regents of the Smithsonian Institution :*

GENTLEMEN: I have the honor to present herewith a report of the operations and condition of the Smithsonian Institution for the year 1881.

As heretofore, in addition to matters pertaining strictly to the Smithsonian Institution, I give an account of the operations of the National Museum and of the Bureau of Ethnology, which by Congress have been placed under the direction of the Smithsonian Institution, as also of those of the United States Fish Commission, of which your secretary is the chief officer.

## THE SMITHSONIAN INSTITUTION.

### INTRODUCTORY.

The operations of the Smithsonian Institution, in their various subdivisions, have been conducted during the year with the usual success, and, I trust, to the satisfaction of all interested.

While, as will be seen, the scale and magnitude of the work accomplished have in many cases been greatly increased in comparison with the work of previous years, at the same time, by a more thorough organization and the increasing efficiency of assistants by long experience, the expenditures have not been augmented. Indeed, in no previous year of the history of the Institution have the funds shown a better condition at the close of the calendar year.

The work of the department of exchanges has never been so large, while the explorations and researches that have been prosecuted have been of very great interest and importance.

The new organization of the National Museum has been successfully established, and it is now in satisfactory working order. The Ethnological Bureau, under the charge of Major Powell, has accomplished a great deal towards the solution of interesting problems connected with the science of anthropology, and the labors of the Fish Commission have largely increased in extent as well as in economical importance.

*The President's Inaugural Reception, March 4, 1881.*—The anticipation of the completion of the new building of the National Museum by the 4th

of March, 1881, naturally suggested the idea of using it for the inaugural reception of the incoming President, and a formal application was made to your honorable body for the privilege. At a meeting called in December, 1880, to consider this subject, it was decided to grant the use of the building for the purpose in question, with the distinct proviso, however, that this was not to establish a precedent for its use for similar purposes hereafter. At the time the building was substantially completed and unoccupied by the Institution for its intended purposes. All that remained to fit it for the object desired by the committee of citizens was the construction of floors in the four main halls and in the rotunda, and the special fittings and embellishments required for the reception. While the other floors were to be of wood, these were to be laid in concrete, and the work was deferred until the building could be cleared of its scaffolding and other obstructions.

Considerable dissatisfaction, however, was expressed at the idea of using concrete for the great floor, and it was decided to refer the matter to Congress, with a view of obtaining, if possible, an appropriation to meet the additional cost of marble and encaustic tiles. As such an appropriation could not be obtained in time for service in connection with the reception, it was determined by the citizens' committee to lay a strong, although temporary, floor in these five rooms, so that the entire ground level of the building could be available. One of the seventeen rooms, containing at the time plaster casts of fishes, was boarded up and reserved. The remainder of the building, without any restriction, was given up to the committee, in accordance with the direction of the Board of Regents.

The Institution made such permanent fittings in the building as were contemplated in the plan, namely, the introduction of electrical wires for the purpose of working time- and watch-clocks, telephones, telegraphs, signals, etc.; the completion of the fitting up of the reception and retiring rooms for gentlemen and ladies, etc.; while the citizens' committee, on its part, in addition to the laying of the temporary floors, erected about ten thousand bins for the reception of hats, coats, and wraps for the visitors, and introduced some three thousand gas-burners, supplied by pipes of suitable size.

The decorations prepared by the committee consisted of a colossal statue of Liberty, erected in the rotunda, a series of emblematical and allegorical shields, monograms of the President and Vice-President, and miles of festooning suspended from the roof.

The reception, which, of course, took place on the night of the 4th of March, was a great success, being attended by about seven thousand persons. The occasion was extremely brilliant. Two powerful electric lights were suspended in the rotunda, and several were erected outside, where they were supplemented by a large number of calcium lights, placed in different parts of the grounds.

As there was no room in the building for supplying refreshments, a



temporary edifice was erected, the entrance to which was made through the eastern doorway.

In the anticipation of a possible failure of the receipts to meet the outlays, the committee asked and obtained permission to give a promenade concert on the following night, which was also largely attended, and the results of the two evenings were entirely satisfactory, enough money having been taken in to pay all expenses, and to relieve a number of persons from their responsibility who had guaranteed the necessary funds for the occasion.

Numerous applications were received from various organizations, civil and military, for the use of the room during the inauguration week, but, in accordance with the instructions of the board, these were refused.

*Death of General Garfield.*—In the last report (for 1880) was mentioned as one of the most noteworthy events of the year the elevation of an honored Regent of the Institution, General JAMES A. GARFIELD, to the highest position in our National Government. Little, indeed, could it then be anticipated that an administration soon to be inaugurated with more than the usual tokens of good will and general satisfaction would, within six months, be suddenly closed under peculiarly grievous circumstances. In the present report we have the painful task of recording the death of the President by a murder most atrocious and unprovoked. Mortally wounded by the bullet of an assassin on the 2d of July, 1881, he lingered through suffering borne with heroic fortitude for two and a half months, breathing his last on the 19th of September.

Eminent for his abilities as a scholar, an orator, and a statesman, distinguished by his dignified and gracious bearing no less than by his prudence and solid judgment, he found time to give a large share of his attention to the meetings and consultations of the Regents, and he always proved a warm friend to this Institution and an earnest champion for the advancement of its highest interests. Thoroughly conversant with the history of the early struggle of opinion in framing the plan for its operations, he was in full accord with its established methods for the promotion of original research. In his eloquent tribute to the memory of Professor Henry, in the Capitol of the Nation, on the occasion of the memorial services held therein on the 6th of January, 1879, he held this language:

"Smithson did not trammel the bequest with conditions. In nine words he set forth its object—'for the increase and diffusion of knowledge among men.' He asked and believed that America would interpret his wish aright, and with the liberal wisdom of science. . . .

"For ten years Congress wrestled with those nine words of Smithson and could not handle them. Some political philosophers of that period held that we had no constitutional authority to accept the gift at all,

and proposed to send it back to England. Every conceivable proposition was made. The colleges clutched at it; the libraries wanted it; the publication societies desired to scatter it. The fortunate settlement of the question was this: after ten years of wrangling, Congress was wise enough to acknowledge its own ignorance, and authorized a body of men to find some one who knew how to settle it. And these men were wise enough to choose your great comrade to undertake the task. Sacrificing his brilliant prospects as a discoverer, he undertook the difficult work. He drafted a paper in which he offered an interpretation of the will of Smithson, mapped out a plan which would meet the demands of science, and submitted it to the suffrage of the republic of scientific scholars. After due deliberation it received the almost unanimous approval of the scientific world. With faith and sturdy perseverance he adhered to the plan, and steadily resisted all attempts to overthrow it. In the thirty-two years during which he administered the great trust, he never swerved from his first purpose: and he succeeded at last in realizing the ideas with which he set out."

By virtue of his office as President of the United States, General Garfield still maintained his connection with the Institution, being by law the presiding officer of the "Establishment," and amid the exacting occupations of his station, he evinced his continued interest in its affairs by promptly attending a called meeting, and visiting officially the Institution, on the 4th of last May. His loss deserves, therefore, from us (apart from its national aspects) a special expression of profound regret, and his memory a special tribute of affectionate gratitude and respect.

*New Regents of the Institution.*—By a very remarkable conjuncture of circumstances the terms of service of the entire body of Congressional Regents of the Smithsonian Institution expired at the close of the Forty-sixth Congress, leaving three to be appointed from the Senate and three from the House of Representatives. The resignation, however, of Hon. Hannibal Hamlin a short time before the fourth of March permitted the president of the Senate to select a successor in the person of Hon. George F. Hoar, who was thus the sole Congressional Regent of the Forty-seventh Congress on its commencement, March 4, 1881. Subsequently, however, Vice-President Arthur appointed Hon. N. P. Hill, of Colorado, and Hon. S. B. Maxey, of Texas, thus completing the number of Senate members of the board.

In the law establishing the Smithsonian Institution provision was made for the appointment of a new Senate Regent every second year, so that at the close of each Congress there would be two members holding over. Owing to the failure on the part of the appointing power to bear this provision in mind, as vacancies occurred Senators have been appointed other than those whose terms were to extend for a full six-year period. In making the recent appointments the attention of the

president of the Senate was called to this circumstance, and he so arranged his selections as to fulfill the original provision, so that of the present Senate Regents the terms of service will be—six years for the Hon. S. B. Maxey, four for the Hon. N. P. Hill, and two for the Hon. George F. Hoar; subject, of course, to renomination by the president of the Senate if they should be re-elected to the Senate at the end of their respective terms.

At the time of writing this report no appointment of Regents from the House of Representatives had been made by the Speaker.

*Services of Hon. H. Hamlin.*—The Smithsonian Institution owes a very great debt of gratitude to the Hon. Hannibal Hamlin, one of the retiring Regents, for advice and assistance rendered during his twenty years' period of service as a member of the board, representing more than half the entire history of the Institution. Many important measures of legislation by Congress, deeply affecting its interest and that of the scientific enterprises in its charge, have been initiated by him and largely consummated through his efforts. The thanks of the Institution are also due to the other retiring members for their attention to its interests.

#### MEETINGS OF THE ESTABLISHMENT AND OF THE REGENTS.

*Meeting of the Members of the Establishment.*—By the first section of the act of Congress organizing the Institution, the President and Vice-President of the United States, the members of the Cabinet, the Chief Justice of the Supreme Court, and the Commissioner of Patents, "during the time for which they shall hold their respective offices, and such other persons as they may elect honorary members," are "constituted an establishment by the name of the Smithsonian Institution." And by the eighth section of the said act "the members and honorary members of the said Institution may hold stated and special meetings for the supervision of the affairs of said Institution and the advice and instruction of the Board of Regents, to be called in the manner provided for in the by-laws of said Institution."

By the third section of the said act "the business of the said Institution shall be conducted at the city of Washington by a Board of Regents, by the name of the Regents of the Smithsonian Institution, to be composed" as specified therein, two of the members of the establishment (to wit, the Vice-President and the Chief Justice) being also named as regents. The distinguished officers of the government thus designated as members of the establishment constitute in effect a board of visitors, invested with the general oversight of affairs and the function of suggesting to the regents such lines of action as to them may seem called for; and endeavors have been made to secure the annual attendance of this body, in compliance with the objects indicated in the organic law. Although a certain day has been specified for the meet-

ing of the members, and for the presentation to their consideration of the general condition of the Institution, it has usually been found difficult to secure their attendance. The pressure of their responsible public duties and the fact that the deliberations and proceedings of the board of visiting members are merely advisory have conspired to prevent them from making any special efforts at meeting together for consultation; and, especially, as from the high character and qualifications of the regents any specific action with regard to matters of administration has heretofore been considered as unnecessary, comparatively little interest in such meetings could be felt by them. Accordingly, although the President is always duly notified in time of the date of the proposed meeting, he has seldom thought it necessary to take any action thereon. In the report of the Institution for the year 1879 a statement was given of the meetings of the members of the establishment held since the organization of the Institution, showing that the whole number during that period had amounted to but nine.

In the case of the incoming administration, however, President Garfield, our lamented coadjutor, called a meeting of the members of the establishment for the 4th of May, 1881; but the only ones in attendance on that day were the President of the board himself and Secretary Lincoln, of the War Department. To them was explained the general condition of the affairs of the Institution, and a personal inspection was made by them of the building and of the collections.

*Meeting of the Board of Regents.*—Reference was made in the last report to the special meeting of the board held on the 8th of December, 1880, for the purpose of considering an application by the citizens' committee for the use of the National Museum building on the fourth of March following, for the purpose of the inaugural reception of the incoming President.

The regular annual meeting of the Regents took place on the 19th of January, 1881, and its early occurrence in the year, as usual, rendered it possible to include an account of its proceedings in the last report, for 1880.

#### THE HENRY STATUE.

It will be remembered that an appropriation of \$15,000 was made by Congress on the 1st of June, 1880, for the erection in the grounds of the Smithsonian Institution of a statue in bronze of Professor Henry, to be executed by Mr. W. W. Story, of Rome, Italy, and that a provisional contract was made with Mr. Story and approved by the Board on the 8th of December, 1880, by which it was stipulated that the work was to be paid for in four equal installments—the first on the completion of the design; the second on the completion of the model in clay; the third on the completion of the statue in bronze, and the fourth and last on the erection of the statue in the Smithsonian grounds. In pursuance of this contract, on the receipt of formal

notice from the American minister at Rome, the Hon. George P. Marsh, that the sculptor had completed the *design* for the statue, the first installment of \$3,750 was paid to him on the 26th of February, 1881. On receiving the certificate of Mr. Marsh that the model in clay had been finished, the second installment of \$3,750 was paid to the sculptor on the 8th of June, 1881. As we are informed by Mr. Story that the bronze casting from this model will very soon be made, the third installment of \$3,750 will be due early in 1882. It is thought that the bronze statue will be at once shipped, and probably received in Washington during the month of March of this year.

In compliance with Mr. Story's request a number of photographs were sent to him to be used in preparing the model of this statue; also, a cast of the face and a bust, executed by Mr. Clark Mills; and, finally, an academic gown belonging to Dr. Maclean, of Princeton, similar to the one used by Professor Henry when a member of the faculty of Princeton College.

As the law of Congress provides that the pedestal of the statue shall be furnished by Mr. Story, at his request estimates for executing the design by him were invited from various manufacturers in the United States. As might have been expected, these varied considerably in amount; but the proposals were all duly submitted to Mr. Story, who selected the offer of the Maine Red Granite Company, which has been assumed by the Quincy Granite Polishing Works. They offer a pedestal according to Mr. Story's plan, the die to be of Red Beach granite and the remainder of Quincy gray granite; the die to be polished, the remainder fine-axed; the whole, securely boxed and delivered in Washington, for \$982.

An important point, namely, that of the precise location of the statue in the Smithsonian grounds yet remains to be considered. I would respectfully suggest that the spot be designated at as early a date as possible; also that provision be made for appropriate ceremonies connected with the inauguration of the statue.

#### FINANCES.

*General condition.*—The condition of the finances of the Smithsonian Institution at the end of the year 1881, is entirely satisfactory. All liabilities have been paid, and a larger balance than usual remains, with which to commence the work of the calendar year 1882. The reason of this surplus is due to several causes, and, among others, to the reduction of the expenses of the system of exchanges, consequent upon the appropriation by Congress, of three thousand dollars, for that purpose, of which one-half has been collected. Several specific appropriations have also been made by Congress to meet the share of expenses of particular departments of the Government, especially of the Engineer Bureau of the War Department and of the Naval Observatory. On this account, although the magnitude of the work is much greater than that

in any previous year, and the expenses correspondingly increased, yet the entire cost to the Institution has been only \$7,467.84. A considerable amount of printing, also, which might have been chargeable to the Smithsonian fund, has been carried on at the expense of the printing fund of the National Museum.

The appropriations for the year by Congress, for the National Museum have been liberal, and the results of the expenditure entirely satisfactory, as I trust will be shown in considering this charge of the Smithsonian Institution.

*Virginia bonds.*—At the meeting of the Board of Regents, January 19, 1881, the Executive Committee was authorized, at its discretion, to dispose of the Virginia securities owned by the Institution and deposit the proceeds in the Treasury of the United States as a part of the permanent fund.

The Executive Committee, after the adjournment of the board, took this subject into consideration, and, after consultation with Mr. Geo. W. Riggs and others qualified to give an opinion on the matter, decided that the time was opportune for the disposal of the Virginia securities, and directed their sale accordingly. The following is a statement of the results of this sale :

\$58,700.00 par value in Virginia consolidated bonds, sold at an average of about 79 per cent., yielded.....	\$46,417 87
\$29,375.07 Virginia deferred certificates, at 13½ per cent....	4,039 08
\$50.13 Virginia consolidated scrip, at 15½ per cent.....	58 03
	<hr/>
	50,514 98

The Executive Committee deposited this amount in the Treasury of the United States, adding to it from the sale of the coupons of Virginia bonds due 1st January, 1881, \$985.02, so as to make the whole sum, \$51,500, to be added to the permanent Smithsonian fund, which was thus increased to \$703,000, and on which 6 per cent. interest will be paid perpetually.

The fluctuations of the stock market, the anticipations of loss from improper legislation and other causes, have thus been removed from the anxieties of the managers of the Institution, the funds are now secure in one investment, and that as enduring as the nation itself.

*Condition of the fund January, 1882.*

The amount received as the bequest of James Smithson, deposited in the Treasury of the United States, in accordance with the acts of Congress of August 10, 1846, and February 8, 1867 .....	\$515,169 00
Residuary legacy of Smithson, added to the fund by act of Congress, February 8, 1867 .....	26,210 63

Addition to the fund from savings, etc., by act of Congress, February 8, 1867.....	\$108,620 37
Addition to the fund by bequest of James Hamilton, of Pennsylvania, 1874.....	1,000 00
Addition to the fund by bequest of Dr. Simeon Habel, of New York, 1880 .....	500 00
Addition to the fund by proceeds of sale of Virginia bonds, 1881.....	51,500 00
<hr/>	
Total permanent Smithsonian fund in the Treasury of the United States, bearing interest at 6 per cent.....	\$703,000 00

The bequest of \$1,000 from James Hamilton, of Carlisle, Pa. (1874), and of \$500 from Simeon Habel, of New York (1880), have been mentioned in previous reports.

In this connection, it is desirable again to refer to the fact that persons intending to leave bequests, or to make donations for the promotion of science, can do nothing promising greater security for their money, or a more faithful administration of the trust, than to follow the examples here cited.

The domain of science is large, its fields of research numerous, and the methods and appliances for successful investigation exceedingly varied. This Institution, with its present equipment, has inaugurated, or prosecuted, or directly fostered original advances in almost every department of physical and biological inquiry. Hence, with its existing facilities and approved experience, it is in a condition to apply most completely and economically any material aid delegated to it, either to purposes of general or special promotion of human knowledge, with but little, if any, expenditure in the necessary apparatus of organization and direction.

Any one, therefore, meditating a moderate bequest (say of a few thousand dollars), and feeling an interest in the advancement of any particular branch of science, could probably obtain in no other way so unabated a devotion of the means to the specific purpose, or so large a return of benefit to future students, and therefore of public credit to the grantor, as by selecting the Smithsonian Institution for his representative and curator.

#### BUILDINGS OF THE INSTITUTION.

*The Smithsonian Building.*—During the year many important changes have been made within the Smithsonian building, which, though involving a comparatively slight expense, have greatly improved the convenience and adaptation of several apartments for the necessary work transacted. Most of the earthen and brick floors of the basement have been replaced by a pavement of concrete, as have also some of the portions previously covered with boards, which furnished a harbor for



rats. These floors, together with the walls and ceilings, have been whitewashed, adding greatly to the purity of the air, and increasing materially the amount of light. Bins have been erected, in which have been stored a large number of the stereotype plates of Smithsonian and Fish Commission reports, and of the bulletins and proceedings of the National Museum, rendering them more readily accessible whenever new issues of either of these works or of any portions thereof may be required.

The most important alteration has been made in the arrangement of the basement rooms of the eastern end of the building, which have been fitted up with more special reference to the conditions required by the increasing amount and complexity of the transportation operations connected with the business of exchanges. These rooms number seven in all, arranged at present in the following order: General reception and delivery; temporary storage; unpacking; assorting; packing; private storage, and storage of duplicates. On the first floor, or main story of the west connecting range, in connection with the introduction of new cases, the ceilings and walls have been painted of a brighter tint, so as to both increase the amount of light and improve the general effect.

At no distant time some expensive work of renovation will be required upon the ceiling of the great hall in the second story of the main building, as in some places the plaster appears in danger of falling off and injuring the cases and specimens on exhibition below.

Complaint has occasionally been made for some years past of the insufficient heating of the main building, and especially of the large upper story known as the ethnological hall, in very cold weather. During the past year the radiators have been rearranged and some additional ones introduced, so that it is hoped there will be no cause of dissatisfaction in this respect in the future.

*National Museum Building.*—This building may now be considered as completed and ready for its final occupation by the various departments which have been assigned to it. An appropriation of \$26,000 was made by Congress for covering the four halls with marble tiling and the rotunda with encaustic tiling. The introduction of a fountain basin, 20 feet in diameter, in the rotunda, greatly reduced the amount of tiling to be done, and added much to the general effect. It is proposed to have a small fountain jet in this basin, and to have various ornamental plants growing in it, forming a pleasing prospect in looking across the long extent of over 300 feet from one main entrance to another.

The only remaining unfinished floor has been covered with boards, like the others of its class.

The ceilings of a part of the building, after they had dried, were found to be insecure, owing to the lack of sufficient bond. As the

plaster was falling in patches from time to time, and greatly endangering life and property in the Museum, it was deemed best to adopt the heroic treatment of taking it all down and calcimining the exposed surface. This occupied the greater part of the summer, and created a vast amount of dust and of refuse matter, to be taken away. This has now been cleared up, and the rooms restored to their previous condition.

It has always been considered desirable to have a supplementary ceiling or skin to the main ceiling, inclosing an air-space between the two, for the purpose of preventing the escape of heat in winter and its access during the summer, and an experimental trial was made by putting up one section of corrugated iron. This has been found to produce a very agreeable effect, and will probably tend, so far as it goes, to remedy the disadvantage referred to. It would be desirable, if the money could be obtained, to complete this work over the entire building, as the hot weather of the last summer proved to be extremely trying inside of the building. The introduction of some additional ventilators considerably relieved this difficulty.

In certain cotton mills in New England the experiment has been made of moistening the air by means of a system of aspirators, for the purpose of improving the facilities of cotton spinning. While accomplishing this object, it has been found that the reduction of temperature in hot weather amounted to 8° or 10° in some cases, while at the same time the air was rendered very much more agreeable as well as more wholesome at all times. An offer has been made by the patentee to apply his apparatus to the National Museum at a cost of about \$7,000, he guaranteeing that a reduction of from six to eight degrees of temperature shall be accomplished during the hot season of the year. This will be a question for determination in the future.

During the very cold weather of the winter of 1880, '81, it was found that the northeastern pavilion occupied by the ethnological and geological bureau was insufficiently heated, this portion of the building being most distant from the furnaces. A supplementary steam furnace was therefore introduced into this division.

The fitting and furnishing of the photographic laboratory in the southeastern building has been completed, and it is now thoroughly adapted to its purposes. The operations of the Institution require a great deal of photographic work, which is now carried on in this building.

The fitting up of the chemical department in the southeastern division has been completed during the year. The laboratory is now fully equipped and able to perform any chemical work required. The chemists have been constantly employed in solving problems committed to them, and a great deal of excellent work has been performed.

A special assay laboratory has been fitted up with the necessary apparatus.

Proper connections have been made in and between all the buildings

for improved telephonic service, and at the present time about thirty telephones are in use, all centering in and intercommunicating through a switch board in the north tower of the Museum. This arrangement is independent of the city office, and by a proper disposition of the watchmen, is available at all hours of the day and night. Its utility is demonstrated every day in facilitating the work of the Institution and in reducing the number of messengers, watchmen, &c., necessary to carry on the various operations.

The room in which the telephone exchange is situated is also the center or headquarters of the remaining electrical service, consisting of a tower clock working 18 electric dials in the two buildings, a watchmen's clock for regulating the rounds of the watchmen and inspectors, a burglar alarm connection with all the doors and windows of the building, call bells and signals everywhere, as well as the telephone service itself. Indeed it is believed that in no building in the world, with the exception, perhaps, of the Grand Opera House in Paris, is there so perfect and complete application of electricity to practical purposes.

A series of tunnels permeates the floors of the building in every direction, and in these are stretched the various wires, some 200 in number, by means of which any electrical service can be maintained. It is proposed, at an early day, to introduce the electric light into the photographic laboratory for use in cloudy days or at night, and also for purposes of illumination when required.

*The Armory Building.*—This edifice, situated at the corner of Sixth street and South B, has for some years been assigned by Congress for the use of the National Museum and of the Fish Commission, and without its facilities of storage, it would be difficult to carry on the work of these two departments. It has been until recently filled with the objects presented to the United States at the International Exhibition of 1876. Most of these, however, have been transferred to the new Museum, where they have been either set up or are waiting their opportunity. The vacancy, however, has been filled by the use of the building for the temporary storage of the immense collection of mineralogy and ethnology made by the United States Geological Survey and the Ethnological Bureau, and also by the storage therein of the movable property of the United States Fish Commission. It is proposed to fit up a part of this building for fish culture and to use it for hatching shad, salmon, and other fish on a large scale.

*Laboratory of Natural History.*—This building, situated at the southwest of the Smithsonian building, and originally erected for the purpose of facilitating the preparation of the material of the International Exhibition of 1876, continues to be of great utility in the functions of the Institution. It is used partly as a stable and carriage-house, and partly as quarters for the practical operations of the Museum, such as the

preparation of skeletons, the mounting of mammals and birds, the preparation of plaster and papier-maché casts, the painting of these casts, and for general photography. The transfer of one division of the work of photography to its new quarters at the southeastern corner of the new Museum building has permitted the assignment of the rooms vacated to the photographic department of the United States Geological Survey, and they have been fitted up for the purpose of preparing the photographic prints of collections of western scenery, Indian life and portraiture, and other interesting objects. These it is proposed to insert in the windows of the new Museum, in which there are nearly 1,000 openings available for this purpose, thus adding very greatly to the attractions of the building. A window has been fitted up experimentally in this manner, and has attracted much attention.

In addition to the work done to the buildings themselves, greatly improved drainage of the new Museum building has been effected. The drain-pipes and sewers originally available for the purpose have been found insufficient for the drainage of  $2\frac{1}{2}$  acres of roof during heavy rains, and an appropriation was made by Congress to remedy this defect. New drain-pipes have accordingly been laid from the northwest corner of the building along the west, south, and east sides, emptying into a large drain and carried directly through the Smithsonian grounds to the great sewer on North B street. Since its completion no difficulty has been experienced in the matter referred to, and it is thought there will be no further trouble.

An appropriation was made by Congress for the construction of a concrete foot-way along the north side of the building, from Seventh to Twelfth streets. This has added greatly to the facility of reaching the building. The repaving of South B street, fronting on the grounds of the Institution and the Museum, replacing the wornout wooden pavement, has also added much to the convenience of approach.

#### ROUTINE WORK OF THE INSTITUTION.

*Administration.*—The executive details of current operations present nothing of sufficient importance to be specially noticed, the organization and *personnel* of previous years having continued in successful operation, and the internal affairs of the Institution having been satisfactorily conducted.

*Correspondence.*—With the increase of work in the various departments of active operations prosecuted by the Institution, there is necessarily a corresponding increase in the general correspondence. It is unnecessary to enter into any detailed description of the different classes of correspondence which constitute the principal work in this branch of current operations, as this has been sufficiently indicated in previous reports. A view of its extent will appear from the general result that the number of letters received, acted upon, filed, indexed,

and bound amounts to somewhat more than 6,000, making about 15,000 pages. The official letters written amount to about 7,000 pages. The correspondence relating to the affairs of the National Museum has been not much less in amount.

#### THE LABORATORY.

One of the provisions specially designated in the fifth section of the act of 1846, establishing the Smithsonian Institution, was that of a chemical laboratory, in which scientific research could be prosecuted. During the entire period of the history of the Institution this requirement has been borne in mind, and at no time has the Institution been without some kind of arrangements for chemical and physical investigation. The great drawback, however, has been the lack of suitable rooms in which the work could be prosecuted without encroaching too much on the other branches, and endangering the safety of the building.

Advantage was taken in the erection of the new Museum to provide suitable accommodations for a chemical laboratory, and I have now the pleasure of reporting that such an establishment is in successful operation, and is believed to be fully equal in its equipment and facilities to any other in the United States. A large room, about thirty feet square, has been fitted up with tables for analytical work, with conveniences for heating, filtering, blow-pipe work, &c. Attached to this is a room 13 feet square, in which are kept the balances and more delicate glass work. A second adjacent room furnishes an office for the chemist in charge. Next to this is an assay laboratory room, 30 feet square, having a stone floor and furnished with muffles, sand baths, water-distilling apparatus, &c.

The work done in the laboratory consists mainly in the examination of the chemical composition of the various undetermined minerals in the National Museum, and in the prosecution of chemical investigations in behalf of the different departments of the government. Requests for such service are always complied with as far as possible. Among such subjects of examination may be mentioned a process for preparing wood for naval purposes, so as to protect it against decomposition and the attacks of insects, presented to the Navy Department. At the request of the department, Dr. Taylor, the chemist of the Institution, was detailed for service with the board, embracing in addition Dr. J. M. Flint, of the Navy, as chairman, and Dr. Mew, of the Army Medical Museum, to thoroughly investigate the subject. Their report has been made and presented to the Navy Department for its consideration.

In addition to this work specimens (most frequently of mineral substances) are continually received by the Institution from private sources in all parts of the country—in number averaging probably some half a dozen a day—with the request for an analysis and report of constituents. As these require merely a general or qualitative determination, they do

not consume a great part of the chemist's time. The work of making precise quantitative assays is much more tedious and laborious, and is undertaken only in the service of the public interests.

The chemist's report, which is given in the appendix, presents some account of the arrangements made in fitting up the new laboratory in the Museum building, as already referred to.

#### RESEARCHES AND EXPLORATIONS.

In the promotion of original research it has always been the policy of the Institution to so employ its limited means as to effect what appeared to be the most promising return in the increase of knowledge, with but little consideration whether such efforts should be made independently or in concert with other agencies. Reserving for a separate notice some of the principal operations undertaken during the year, in co-operation with other institutions, reference will here be made to the researches and explorations of which the Institution has borne alone the burden and responsibility. Of these one of the most important was that of Mr. L. Belding, of Stockton, Cal., who, at our suggestion, visited Guadalupe and Cerros Islands on the coast of Lower California, as well as certain portions of the main land. His collections of birds, fishes, plants, &c., have been submitted to examination, and include many interesting objects. This gentleman returned home in the summer, and started again to his chosen field of labor in December, proceeding direct to La Paz, on the Gulf of Lower California, where he expected to remain till spring, and then to visit Cape Saint Lucas, a region made memorable by the labors of Mr. John Xantus.

Mr. Xantus, in his explorations twenty years ago, collected numbers of new species, the types of which have been lost by deterioration, and it is considered especially advisable to secure fresh specimens of these and of any additional species that may be procurable.

During the summer, Mr. James Bell, of the Land Office, stationed in Florida, has utilized his spare moments in continuing the explorations referred to in the report for 1880. His contributions have consisted especially in living reptiles for the modeling department of the National Museum. Numbers of birds, Indian relics, &c., have also been furnished by him.

Mr. S. T. Walker, also working in West Florida, but farther north than Mr. Bell, has made numerous contributions of interest from the Indian mounds and graves, thereby greatly extending our knowledge of the archæology of Western Florida.

Among the most interesting and important explorations of the year in Florida is that of Mr. J. F. LaBaron, who discovered a rich deposit of fossil bones, which are now in the hands of Professor Leidy for examination and determination. Among these it is believed there are several new species of mammals and reptiles.

Prof. O. P. Hay, of Irvington, Ind., with the co-operation of the

Smithsonian Institution, has continued his series of investigations into the ichthyology of the Mississippi Valley, collecting many rare and new species of fish, a series of which has been transmitted to the Institution.

Dr. R. Ellsworth Call, of Des Moines, has also made similar explorations relating more specially to fresh water shells.

Hon. John G. Henderson, of Winchester, Ill., has continued and completed certain explorations in the mounds of that State at the expense of the Smithsonian Institution. Some very valuable and interesting objects have rewarded his search.

Mr. B. F. Norris, Superintendent of the National Yellowstone Park, has brought to the Institution a large collection of the natural objects of the park, among them a fumarole of a small geyser, which it is proposed to utilize for the purpose of a fountain in the rotunda of the museum.

Prof. C. H. Gilbert, who was associated with Professor Jordan in the exploration of the ichthyology of the Pacific coast of America (as mentioned in the Report for 1880), remained for some time at Panama, continuing his gatherings, and then returned to his residence at Bloomington, Ind. The results of his work and that of Professor Jordan have been published from time to time in the proceedings of the National Museum. Mr. Gilbert will probably return to Central America before long, under the auspices of the Smithsonian Institution, to continue and complete his work.

Mr. H. H. Rusby, of Franklin, N. J., has completed during the year his researches into the botany of New Mexico, in which he has been engaged for several years past. The Institution was able to obtain for him important facilities in the way of transportation of his collections, and has secured thereby a series of his specimens.

During a recent visit to Mexico of Mr. S. B. Evans, of Ottumwa, Ill., in the interest of archæology, the Institution was able to render him assistance by a letter of introduction to its correspondents in that country. Mr. Evans has brought back quite an amount of interesting information, especially relating to his discovery of a new so-called sacrificial stone.

Mr. F. A. Ober, in the course of a visit to Mexico during the past winter, obtained some copper axes and some interesting birds.

A large amount of exploration has been prosecuted by correspondents of the Smithsonian in the West Indies and South America; among these may be mentioned the work of Dr. H. A. Alford Nicholls, of Dominica, an English physician of much eminence in his profession, and distinguished as a naturalist, who furnished several new species of birds and a first installment of a large collection of fishes. Dr. Nicholls proposes to prepare a work on the ichthyology of Dominica, to be published by the Smithsonian, and to send specimens to Washington for identification,

A similar arrangement to that made with Dr. Nicholls has been entered into with Mr. Musgrave, of Jamaica, his object being to extend and complete the work upon the natural history of Jamaica commenced many years ago by Mr. Gosse. A large collection of fishes already sent in has been under investigation by Mr. Goode and Dr. Bean. Valuable contributions have also been received from Hon. Edward Newton, of the colonial government of Jamaica.

Mr. L. Guesde, of Guadaloupe, has undertaken to furnish to the Institution, for publication, a series of drawings illustrating the archæology of that island. He has accordingly transmitted a large number of descriptions and figures of many curious objects, of which Professor Mason has charge in editing them for the report. He has also furnished a number of specimens of reptiles and fishes illustrating the natural history of the island.

Mr. Wells, of Antigua, has aided the Smithsonian Institution by sending birds, fishes, and ethnological objects. His labors and those of other valued correspondents in the West Indies were secured to the Institution by Mr. Frederick A. Ober in the course of tours of service in the West Indies. This co-operation of resident naturalists in the West Indies has been especially interesting to the Smithsonian Institution, as there still remain many important problems in relation to that region.

The work of Mr. P. Figyelmesy, at Demerara, for several years has contributed much to the ethnology and natural history of the colony. Similar work has been done by Dr. C. Hering, at Surinam. No special research has been carried on in other parts of the Old World, with the exception of that connected with the "Palos," Captain Green, commander, referred to further on.

In the report for 1879, at p. 45, mention was made of the co-operation of the Smithsonian Institution with the Navy Department and Mr. James Gordon Bennett in the preparation for natural history work, on board the "Jeannette." At the request of Mr. Bennett the Institution secured the services of Mr. Raymond L. Newcomb, an experienced naturalist and taxidermist, of Salem, Mass., and prepared for him a complete outfit, principally at the expense of Mr. Bennett. When the vessel touched at St. Michaels, in 1879, some interesting specimens had already been gathered by Mr. Newcomb, and the expectation of interesting results in the future was, of course, very reasonably entertained. We now have the information that the steamer was crushed in the ice, and that the officers and crew betook themselves in three boats to the mainland. Information has been received from two of these boats; one with Engineer Melville in charge, and including Mr. Newcomb in the party. Of the third nothing has yet been heard. It is probable that any collections made by the steamer have been lost in the wreck; but there is no doubt that Mr. Newcomb, on his return, will be able to furnish interesting information, either from notes preserved, or from personal recollection.

During the early part of 1881, in response to an urgent public senti-



ment, Congress made an appropriation for the purchase of a whaling steamer, the "Helen and Mary," then at San Francisco, and to fit it out for the purpose of engaging in the search for the "Jeannette." A board of naval officers was formed to select a plan for search and prepare the necessary instructions. Of this board Admiral John Rodgers was president, and in commemoration of his services in that respect, and also of his having been the only American naval officer who had previously made an official exploration in the arctic region to be visited, the name of the vessel was changed to that of the "Rodgers," and Lieutenant Berry placed in command. Although extended investigations in natural and physical science were not contemplated by the board, yet, with a proper spirit of inquiry, Lieutenant Berry asked for suggestions as to what could be done in the line of natural history, and they were furnished by the Smithsonian Institution with much pleasure, together with some apparatus, alcohol, &c., necessary in connection with the capture and preservation of specimens.

The "Rodgers" made a complete exploration of the mysterious Wrangel Land, and entered into winter quarters on the shores of Siberia, expecting in the spring to resume its search for the "Jeannette." It will, however, be made acquainted with the fate of the "Jeannette" in time to prevent any waste of effort, and the vessel, it is understood, will return at once to the United States.

No report has yet been made as to any scientific results obtained by the expedition.

For some years past Commander F. M. Green, of the Navy, has been engaged, under the direction of the Bureau of Navigation, in making a determination of the longitudes of various points in the Atlantic Ocean and adjacent thereto, the work being mainly done by means of the numerous submarine and land telegraphs. In the spring of 1881 Commander Green was ordered to continue his work in the Pacific Ocean, and the steamer "Palos," then in the Chinese and Japanese seas, was placed in readiness for his use. Commander Green invited the co-operation of the Smithsonian Institution in making his work productive of results in the department of natural history as well as in that of physical science; and Dr. F. C. Dale was detailed as a surgeon, and a gentleman well and favorably known for his attainments as a naturalist. He took with him as an assistant Mr. P. L. Jouy, for a long time in the employ of the National Museum, and accomplished in the preservation of objects of natural history. The party proceeded by land to San Francisco, and thence by steamer to Yokohama, the commander there meeting the vessel and entering upon his work. Very valuable collections were made, first in Japan, and secondly at Shanghai, in China. The portion of the expedition that was sent to Vladivostock also obtained some interesting collections. Through their instrumentality, also, the government authorities in Tokio and the Natural History Museum at Shanghai contributed quite largely to the collections,

with the understanding that some specified exchanges were to be returned by the National Museum. Six cases of birds, mammals, alcoholic specimens, &c., have already been received from Dr. Dale, and several others are now on the way. It is quite probable that the results of this expedition will rank favorably with those procured by any nation from the same region.

While connected with the expedition under Commander Lull, U. S. N., for determining the character and best route of a canal from ocean to ocean through Nicaragua, Dr. J. F. Bransford made some interesting collections in natural history, ethnology, and archæology, which were presented by him to the Smithsonian Institution. Additional information being required in regard to this route, Dr. Bransford was twice sent out to again review the ground and to investigate more particularly certain obscure points. In both cases he asked and obtained suggestions from the Smithsonian Institution as to collateral researches, and made some extremely important gatherings of specimens for the National Museum. The results, so far as the archæology of Nicaragua is concerned have lately been published by the Institution in a well illustrated quarto memoir.

Dr. Bransford was recently again detailed by the Navy Department to revisit Central America, for the purpose of making some determinations as to the natural conditions and commercial relations of certain important drugs largely used in medicine at the present time; and was directed also to apply his previous experience as an archæologist to the solution of some problems of the science, especially in Guatemala, Costa Rica, and Honduras. He accordingly left Washington in December last on his mission, proceeding directly to Aspinwall and Panama. His route will take him first to Guatemala, thence across to Coban, and then returning by the Gulf of Nicoya. One of the problems submitted to Dr. Bransford is the discovery of the precise locality whence the material for the many jade and jadeite ornaments, found in various parts of America, has been derived. Such objects are among the choicest and most highly prized of American antiquarian collections, while the mines whence the raw material has been derived are entirely unknown. It has been suggested that the material must have been brought in the rough from China or Australia, although there is no good evidence to prove such a conclusion.

Should Dr. Bransford find the locality of this mineral it will contribute towards solving one of the most interesting problems of the day.

The co-operation of the Smithsonian Institution and that of the United States Signal Office of the War Department in prosecuting researches into the physical condition of various portions of North America, which has been adverted to in previous reports, continues in a very satisfactory manner. This relationship was first established by the transfer to the Signal Office of the entire system of meteorological research initiated and for nearly a quarter of a century prosecuted by

the Smithsonian Institution. Since then all the material and problems connected with meteorology have been transferred to the Signal Office, which on its part has not failed to extend its aid to the Institution in connection with branches of science other than those constituting more particularly its functions. Many important results, both in zoölogy and ethnology, accomplished by the Institution in relation to Northern, North-eastern, and even Arctic America, have been attained in connection with General Myer, and afterwards his successor, General William B. Hazen. In establishing meteorological stations in different parts of Arctic America, the Smithsonian Institution has been invited to nominate observers, who, while competent to the duties of the Signal Office, may, if convenient, be able to make collections of objects in natural history and ethnology. In pursuance of this co-operation, a number of years ago Mr. Lucien M. Turner was selected and stationed first at Saint Michael's and then along the chain of the Aleutian Islands. Mr. Nelson succeeded him at Saint Michael's, and continued his work.

Under instruction of the Treasury Department, through Mr. E. W. Clarke, chief of the Bureau of the Revenue Marine, Captain Hooper, in command of the revenue cutter "Corwin," visited the arctic coast, both in the interest of the revenue service and for the purpose of obtaining information in regard to the "Jeannette." He was instructed to take Mr. Nelson to Saint Michael's, and give him an opportunity of visiting Saint Lawrence Island, the special object being to allow the collecting of the remains of the Esquimaux who to the number of several hundred perished there by starvation. Mr. Nelson was accordingly taken on board, and obtained on the island, in addition to a very fine collection of implements, utensils, dresses, &c., a large number of crania, filling an important deficiency in the Museum. The vessel then proceeded to various points on the Siberian coast, and subsequently made the first known landing on Wrangell Land, that mysterious region which had been the special object of investigation on the part of the "Jeannette."

On the island a magnificent polar bear, killed by the party, was brought back by Mr. Nelson, and is now duly exhibited in the National Museum.

The thanks of the Institution are due not only to the Treasury Department but also to Captain Hooper for his kind co-operation in Mr. Nelson's work, by rendering all possible facilities.

Mr. Lucien M. Turner, who, under orders from the signal service of the United States Army, to make meteorological observations in Alaska, arrived at Unalashka Island May 10, 1874, succeeded during the five days he remained there in collecting several species of birds. He reached Saint Michael's, Alaska, May 25, commencing his meteorological work June 26, and during the leisure permitted by close attention to his official duties, continued his collections of natural history specimens from the locality, until July 9, 1877, when at his request

he was granted leave to return to Washington. In March, 1878, Mr. Turner again proceeded to Alaska, under orders from the signal service, to establish meteorological stations at Saint Paul's Island, Attu Island, Atkha Island, Belkovsky on the peninsula of Aliaska, and at Nushagak on Bristol Bay. During the year he visited, through the kindness of the Alaska Commercial Company, the stations at Kuskokvim River, Ugashik, Tugiük, Nushagak, Port Moller, Akootan, and Saanak Island, spending the winter at Iliuliuk, on Unalashka Island. He passed the summer of 1879, at Atkha Island, collecting many natural history specimens: spent the winter at Unalashka Island; and in June, 1880, went to Attu Island, remaining there till May, 1881.

During the leisure hours at his disposition he collected for the National Museum one hundred and sixty species of birds—some of which were for the first time ascertained to occur within our limits, thirty species of fish, several species of mammals, nearly thirteen thousand specimens of insects, a good series of the land and marine shells, several thousand specimens of plants—embracing over two hundred species; and paid especial attention to collecting a complete series of implements and other articles of ethnological and archæological character embracing over three thousand specimens, some of which were for the first time obtained. Much attention was given to the study of linguistics of the Unaleet and Malemut Orarians, Nulato, Ingalet, and Unalashkan Aleuts. The vocabularies are comprehensive, containing not only a list of words, but much of etymologic value, stories, history, and other valuable information concerning these people, of whom little was previously known.

Mr. E. W. Nelson, also under orders from the signal service, as a meteorological observer in Alaska, was authorized by co-operative arrangement between that bureau and the Institution, to prosecute investigations during his intervals of official leisure, for the advancement of scientific knowledge. He reached the Aleutian Islands in May, 1877, and for about a month availed himself of the opportunity of making collections in Unalashka of bird skins and of fishes. He also procured ethnological specimens, both recent and from the ancient village sites, of which considerable numbers are found along the shore. Visiting Saanak Island (to the eastward of Unalashka,) he made various interesting notes on the life and habits of the sea-otter, this curious animal being particularly abundant in this locality. Leaving in June, 1877, for Saint Michael's, Norton Sound, Mr. Nelson occupied his spare time for a year in making collections of mammals, birds, fishes, and insects. The field among the Eskimo of this region was also very rich in ethnological material and observations. Most friendly and valuable assistance in these researches was rendered by the agents of the Alaska Commercial Company, and by the fur traders connected with it.

During the winter of 1878-'79, Mr. Nelson made a dog-sledge journey of over a thousand miles in the country between the Lower Yukon and

the Kuskokwim Rivers, securing over three thousand ethnological specimens, of which a considerable portion consisted of articles of carved walrus ivory. Much information was also noted regarding the topography of the country, as well as about its people and productions.

In May and June, 1879, the mouths of the Yukon were visited to study the habits of the breeding water-fowl, and a fine series of the skins and eggs of the emperor goose were obtained. The following winter, from February 9th to April 3, 1880, was occupied in a reconnaissance of the coast region, from Saint Michael's north to Sledge Island near Bering's Straits.

A large series of ethnologica was secured, besides copious notes upon the people and their language. November 16, 1880, to January 19, 1881, was occupied in a sledge journey into the interior, beyond the coast belt occupied by the Eskimo, into the country of the Ingaliks or Indians. As on the previous journeys, a large series of ethnologica and field-notes were secured.

June 25, 1881, through the courtesy of Mr. E. W. Clarke, chief of the Revenue Marine Bureau, the revenue steamer "Corwin" was permitted to take Mr. Nelson on board, at Saint Michael's, to accompany her during her cruise in the Arctic, in the course of which he visited Saint Lawrence Island, in Bering's Sea, where about eight hundred Eskimo perished in a famine two winters before. From this sad mortuary nearly one hundred crania were secured, besides many implements.

The remainder of the season was spent in cruising along the Alaskan coast as far north as Point Barrow, and along the Siberian coast from Plover Bay, Bering's Sea to North Cape in the Arctic. Visiting and exploring Herald Island, and a part of Wrangell Island, the "Corwin" returned by the Aleutian Islands to San Francisco, arriving there October 20, 1881.

In summing up the direct results of Mr. Nelson's work in the north, the unbroken series of about 12,000 meteorological observations must be mentioned first, since to obtain these was the primary object of his residence there. In addition to these there were obtained about 9,000 ethnological specimens, 2,100 bird skins, 500 mammal skins and skulls, 400 fishes, and various other specimens, besides vocabularies of seven or eight Eskimo dialects, with accompanying linguistic notes and a large amount of manuscript material upon all the branches in which collections were made. Over 100 photographs of the people and other scenes were secured during the last year of his residence in the north. The necessary expenses attending this work, outside those appertaining strictly to the meteorological work, were met by an allowance from the Institution, where the specimens are stored at present awaiting the elaboration of the reports.

During the year 1881 three additional stations were established by the Signal Office—one at Nushigak, on Bristol Bay, in charge of C. L. McKay; one at Unalashka, in charge of F. L. Applegate, and

the third at Sitka, in charge of Mr. John J. McLean. Some very interesting archæological collections have already been received from Mr. McLean, and others are expected from the other gentlemen mentioned. All were provided by the Smithsonian Institution with apparatus and material for collecting and preserving specimens and the means of procuring goods for making exchanges with the natives.

Of the localities mentioned Bristol Bay is the one least known to naturalists and promising the largest returns.

In the system of international meteorological research, decided upon at a convention held a year or two ago, it was desired that the United States should establish a station at Point Barrow, the northernmost point of Continental America and in Greenland, and both these measures were carried out by the signal service during the past year, and a specific appropriation was made by Congress for the purchase of a vessel at Newfoundland, at which point the Franklin Bay party, under Lieutenant Greely, embarked on board the whaling steamer "Proteus," a vessel admirably adapted for its purpose, which had been previously selected by Capt. H. C. Chester, an employé of the U. S. Fish Commission. The vessel made a brief but successful voyage, landing its party without any impediment and returning—after but a short absence, to Newfoundland. It is expected that this vessel will be sent up during the coming summer to carry additional supplies and bring back the reports and collections.

No special detail of a naturalist was made for this expedition, as Dr. Pavy, of the Howgate expedition of 1880, was expected to join it, and did so in Greenland.

A second international station—that at Point Barrow—was also established by the Signal Office during the year, and was placed in charge of Lieutenant Ray, an experienced army officer, and provided with suitable apparatus. At the request of General Hazen, the Smithsonian Institution nominated Professors Murdock of Madison, Wis., and Smith of the Westfield Normal School, both experienced naturalists and collectors, as observers. They were ordered to Washington to undergo a training for physical research, especially as to more detailed observations in meteorology, terrestrial magnetism, and astronomy. The party proceeded from San Francisco by a schooner, chartered for the purpose, and reached their destination without any untoward event. It is expected that the advices of next summer will report them as comfortably established and in the successful prosecution of their work. A part of the expense of this party is borne by the Coast and Geodetic Survey.

For some years one of the most valued coadjutors of the National Museum has been Capt. Charles Bendire, of the First Cavalry, a distinguished officer of the service and a competent naturalist and observer. Reference has already been made to his services in 1880, in visiting the interior of Oregon and Washington Territory for the purpose of solving

some unsettled problems in regard to the salmonidæ of the coast. His observations proved entirely sufficient for the purpose of informing us of the character of the trout of Wallowa Lake, which turns out to be not a peculiar species of the lake, as was supposed, but an anadromous salmon found along the entire coast of Washington Territory and elsewhere, and characterized during the breeding season by a peculiar red color.

Captain Bendire having again offered his services to the Institution, he was authorized by the War Department to visit certain regions, especially that of the valley of John Day River. With a grant of money from the United States Geological Survey for necessary and incidental expenses, Captain Bendire made his expedition, and sent in a large number of packages of well-selected specimens, which will shortly become the subject of investigation. Some collections of fishes and other objects in alcohol were also gathered and forwarded by Captain Bendire.

Private Charles Ruby, of the Army, while at Fort Laramie, exercised his skill as a taxidermist, in collecting specimens of the wild animals of the country and sending them to the Smithsonian Institution. An arrangement was made by which he was transferred to a region better adapted to his work, near Fort Shaw, in Montana. Here he has continued his co-operation, and has furnished a large number of skins of larger mammals, a number of which have been mounted and introduced in the National Museum.

The usual co-operation of the medical branch of the Army in the matter of exploration has also been continued, many medical officers having forwarded collections of greater or less magnitude, among these are included a number of contributions of living reptiles to the Institution, for the purpose of being cast in plaster and placed in the appropriate gallery of the Museum.

Mention should not be omitted of the service rendered by officers of the Army in New Mexico and Arizona, as stated in the report of Mr. Stevenson, of his explorations in Arizona.

#### PUBLICATIONS.

It may not be deemed superfluous to repeat frequently, for the information of those who may not have ready access to previous volumes of the annual report, that the publications made directly or indirectly by the Institution (always regarded as the most important of its agencies for the "increase and diffusion of knowledge among men"), are distributed into three series. The first series comprises the "Smithsonian Contributions to Knowledge," published in quarto size, and designed to embrace only the discussions of original investigations, constituting new additions to knowledge. This series now numbers twenty-three volumes, averaging about 600 pages. The second series comprises the "Smithsonian Miscellaneous Collections," published in octavo size, and including, in addition to other original memoirs, the bulletins and pro-

ceedings of the National Museum, special reports on particular subjects of biological or physical research, tabular compilations of classification, natural constants, and such other miscellaneous information as is deemed of value to the scientific worker or student. This series numbers twenty-one volumes, averaging about 800 pages each. The third series comprises the Annual Reports of the Regents, presented to and published by Congress. Accompanying the report proper (giving the statistical and financial summaries required by law) interesting records of particular advances and discoveries, or of the progress of science generally, have been presented in a general appendix, making the volume much sought after.

*Smithsonian Contributions to Knowledge.*—Of the quarto class of publications the following memoirs have been collected and published during the past year, as volume XXIII of the "Contributions to Knowledge," forming a volume of 767 pages, illustrated by 155 wood-cuts and 16 plates:

1. Introduction, contents, &c., 16 pages.

2. *Lucernariæ and their allies*; a memoir on the anatomy and physiology of *Halicystus Auricula* and other *Lucernarians*, with a discussion of their relations to other *Acalephæ*, to *Beroids*, and *Polypi*. By Henry James Clark, B. S., A. B. (Published April, 1878.) 4to, 138 pp., 4 wood-cuts and 11 plates, containing 145 figures. As stated in the report for 1878, the lamented author died while his work was passing through the press.

3. On the geology of Lower Louisiana and the salt deposit on *Petite Anse Island*. By Eugene W. Hilgard, Ph. D., professor of chemistry in the University of Mississippi. (Published June, 1872.) 4to, 38 pp., 6 wood-cuts.

4. On the internal structure of the earth, considered as affecting the phenomena of precession and nutation; supplementary to an article under the above head in *Smithsonian Contributions to Knowledge*, vol. XIX., No. 240, being the third of the problems of rotary motion. By J. G. Barnard, U. S. Army. (Published August, 1877.) 4to, 20 pp., 4 wood-cuts. This memoir is a continuation of the mathematical discussion of an important problem of gyratory motion, published in 1872, resulting in a modification of the conclusion formerly arrived at by the author, and at the same time controverting the celebrated memoir of Mr. Hopkins, which had been supposed to demonstrate that the terrestrial gyration known as the "precession of the equinoxes" is incompatible with a molten or fluid interior to our globe. The question of the internal fluidity of our earth thus appears to be now left (as formerly) to be settled by purely geological evidences.

5. *A Classification and Synopsis of the Trochilidæ*. By Daniel Giraud Elliott, F. R. S. E. (Published March, 1879.) 4to, 289 pp., 127 wood-cuts. This work comprises a full description of every known spe-



cies of humming-bird. In many cases the head, wing, and tail of the bird are figured by wood-cuts inserted adjacent to the descriptive text.

6. *Fever. A Study in Morbid and Normal Physiology.* By H. C. Wood, A. M., M. D. (Published October, 1880.) 4to, 266 pp., 16 wood-cuts and 5 plates, containing 17 figures. This memoir was more particularly described in the annual report for 1880.

*Antiquities of Nicaragua.*—Of separate memoirs published during the year the first is *Archæological Researches in Nicaragua*, by J. F. Bransford, M. D. (Published January 1881) 4to, 100 pp., 202 wood-cuts and 2 plates, containing 40 figures. This memoir gives an account of a large number of interesting relics of the aboriginal inhabitants of Nicaragua, disinterred by Dr. Bransford himself during visits to that place in 1876 and in 1877. The fine collection of ancient American burial-urns, pottery, and other objects thus obtained, amounting to about 800 articles, has been deposited in the National Museum. Of these not more than about sixty were acquired by gift or purchase, the remainder having been dug out from their original deposit by Dr. Bransford, or under his immediate direction. More than a hundred of the larger urns were found to contain human bones.

*Rain-fall Tables.*—Another publication of the past year is, *Tables and Results of the precipitation in rain and snow in the United States and at some stations in adjacent parts of North America and in Central and South America*, collected by the Smithsonian Institution and discussed under the direction of Joseph Henry and Spencer F. Baird, secretaries. By Charles A. Schott. Second edition. (Published May, 1881.) 4to, 269 pp., 8 wood-cuts, 5 plates, and 5 maps or charts, exhibiting by isohyetal curves the mean rain-fall for each of the four seasons and for the year. The first edition of this work was published by the Institution in March, 1872, giving a tabulation of observations to the close of 1866. As a considerable amount of material has been subsequently accumulated, it was thought but just to have this additional information incorporated in a new and thoroughly revised edition of the tables. The work of arrangement and discussion was committed to the same editor, Mr. Charles A. Schott, assisted by Mr. E. H. Courtenay, and the new tables include observations made from the beginning of 1867 to the end of 1874, and in some cases to the end of 1876. This extension has resulted in increasing the size of the original work by about 100 pages. It is believed that this compilation will prove a valuable contribution to the study of American meteorology and climatology.

*Smithsonian Miscellaneous Collections.*—Two volumes of the octavo series have been published during the year, forming volume XX and volume XXI of the "Miscellaneous Collections."

Volume XX consists of the following parts:

1. Bulletin of the Philosophical Society of Washington. Vol. I, March, 1871, to June, 1874, 8vo., 218 pp., 3 wood-cuts.

2. Bulletin of the Philosophical Society of Washington. Vol. II, October, 1874, to November 2, 1878, 8vo., 452 pp., 9 wood-cuts and 4 plates.

3. Bulletin of the Philosophical Society of Washington. Vol. III, November 9, 1878, to June 19, 1880, 8vo., 169 pp., 7 wood-cuts.

Volume XXI contains the following memoirs:

1. James Smithson and his Bequest. By William J. Rhees, 1880, 8vo. 76 pp., 9 plates.

2. The Scientific Writings of James Smithson. Edited by William J. Rhees, 1879, 8vo., 166 pp., 32 wood-cuts and 1 plate.

3. A Memorial of Joseph Henry, 1880, 8vo., 532 pp., and 1 plate. This latter work comprises, 1st., an account of the obsequies, with funeral sermon, &c.; 2d the memorial addresses and services at the National Capitol, by direction of Congress; and, 3d, as an appendix, selected proceedings of and addresses before learned societies with which Professor Henry had been more intimately connected.

*Bulletins of the National Museum.*—This series of octavo publications, illustrating the zoölogical and ethnological collections in the United States National Museum, has been authorized, as heretofore stated, by the Department of the Interior, and the expenses of printing a first issue of the same are sustained by that department. The stereotype plates are subsequently employed in making up volumes of the "Miscellaneous Collections." During the year Bulletin No. 21 has been published, comprising a carefully prepared digest revising the "Nomenclature of North American Birds, chiefly contained in the United States National Museum," by Robert Ridgway, 1881, 8vo., 94 pp.

*Proceedings of the National Museum.*—In continuation of the systematic description of new species received by the National Museum, and other papers of interest to the naturalist, collected under the title of "Proceedings," a volume has been published during the year, comprising valuable papers by Tarleton H. Bean, S. T. Cattie, F. M. Endlich, Samuel Garman, Charles H. Gilbert, Theodore Gill, G. Brown Goode, O. P. Hay, Angelo Heilprin, David S. Jordan, George N. Lawrence, W. N. Lockington, Richard Rathbun, Robert Ridgway, John A. Ryder, Rosa Smith, S. I. Smith, James G. Swan, A. E. Verrill, and Charles A. White. This completes volume III of Proceedings of the United States National Museum. 1881, 8vo., 594 pp.

*Check-list of Smithsonian Publications.*—During the latter part of the year a new and revised edition of the list of publications of the Institution was printed, forming No. 487 of the Miscellaneous Collections. (December, 1881), 8vo., 22 pp.

*Smithsonian Annual Report.*—The official report of the Board of Regents for the year 1880 was presented to Congress January 19, 1881, and an edition of 15,560 copies was ordered to be printed. This included the usual reports of the Secretary, of the Executive Committee, of the Board of Regents, and of the National Museum Building Commission, together with the Journal of proceedings of the Board of Regents. The "General Appendix" to the report, made up subsequently, comprised, first, a record of recent scientific progress, which is regarded as a valuable feature of the annual, and one desirable to be permanently maintained. The various subjects were assigned to different collaborators as follows: Introduction, by the Secretary; recent progress in Astronomy, by Prof. E. S. Holden; in Geology and Mineralogy, by Dr. George W. Hawes; in Physics and Chemistry, by Prof. George F. Barker; in Botany, by Prof. William G. Farlow; in Zoölogy, by Dr. Theodore Gill; in Anthropology, by Prof. Otis T. Mason. The remainder of the General Appendix was occupied, secondly, with a bibliography of Anthropology, by Prof. O. T. Mason; abstracts of Anthropological correspondence of the Institution; a report on the Luray cavern; a discussion of Professor Snell's barometric observations, by Prof. F. H. Loud; an account of investigations relative to illuminating materials, by Joseph Henry (reprinted from the United States Light-House Report for 1875); a synopsis of the scientific writings of Sir William Herschel, by Prof. Edward S. Holden and Charles S. Hastings; and, lastly, reports giving an account of the principal astronomical observatories of the world.

#### ASTRONOMICAL ANNOUNCEMENTS BY TELEGRAPH.

An important function of the Institution, initiated by my predecessor in 1873, and since carried out with great regularity, as exhibited in the annual reports for nearly a decade past, comprises the transatlantic interchange by telegraph of important astronomical discoveries requiring immediate attention from numerous or widely separated observers. These astronomical announcements through the Smithsonian Institution have been of great value in the promotion of science, and have been highly appreciated.

The announcements of astronomical discoveries made during the past year are as follows:

#### *List of minor planets discovered in 1881.*

No.	Name.	Date.	Discoverers.	Discoverer's No.	Observatory.
220	.....	Feb. 23.	Palisa.....	29th.	Pola.

It is noteworthy that last year is the first one since 1859 in which more than one planetoid has not been discovered. The annual numbers recorded during the last twenty-five years are as follows :

1857.....	9	1862.....	5	1867.....	4	1872.....	11	1877.....	11
1858.....	5	1863.....	2	1868.....	12	1873.....	6	1878.....	12
1859.....	1	1864.....	3	1869.....	2	1874.....	6	1879.....	20
1860.....	5	1865.....	3	1870.....	3	1875.....	17	1880.....	8
1861.....	10	1866.....	6	1871.....	5	1876.....	12	1881.....	1
	30		19		26		42		52

It thus appears that the quinquennial average of discoveries, so far from decreasing, has for the past twenty years steadily and notably increased, giving no indication, therefore, of an immediate or early exhaustion of material. This is due, partly, to the closer scrutiny given to this field by astronomers, partly to the increased number of observers, and partly to improvements in their instruments and in their systematic methods of observation.

This remarkable group of planetoidal or meteoroidal bodies forms a tolerably wide zone or ring between the orbits of Mars and Jupiter, separating the four interior and smaller planets (including our earth) from the four exterior and much larger planets. It has been estimated by Leverrier and others, from the motion of Mars (the amount of displacement of the apsides, due to the amount of counteraction of the solar gravitation by the external attraction), that the entire mass of this ring of meteors cannot much exceed a fourth of that of our earth. In no great time, therefore, the discovery of new members of this group must become more and more rare. The smallest thus far observed do not probably exceed 20 or 30 miles in diameter, and the number which will remain forever unseen, by even the highest powers of the telescope, may very many times surpass the number ever made visible.

*List of comets observed in 1881.*

No.	Name.	Date.	Discoverer.	Observatory.
I	Faye's comet.....			
II	.....	May 1	Swift .....	Rochester, N. Y.
III	.....	May 21	Tebbutt .....	Windsor, New South Wales.
IV	.....	July 16	Schöberle .....	Ann Arbor, Mich.
V	Encke's comet....	Aug. 27	Common .....	Ealing, England.
VI	.....	Sept. 20	E. E. Bernard .....	Nashville, Tenn.
VII	.....	Oct. 4	Denning .....	Bristol, England.
VIII	.....	Nov. 16	Swift .....	Rochester, N. Y.

The generous co-operation of the large telegraph companies, embracing those both of the transatlantic cable and of the widely ramified land lines, cannot be too often or too warmly acknowledged. The lib-

eral spirit with which these scientific messages are dispatched across the world, without charge to the Institution, is a most gratifying tribute of sympathy and confidence on the one hand, and a conspicuous illustration of enlightened appreciation of the character of information thus diffused on the other.

The European centers to which our telegrams of American discoveries are gratuitously distributed are the National Observatories of Greenwich in England, Paris in France, Berlin in Germany, Vienna in Austria, and Pulkova in Russia. The telegraphic announcements of foreign discoveries are gratuitously distributed to nineteen of the leading establishments in the United States, as well as to some of the daily papers and to the Associated Press generally.

#### INTERNATIONAL EXCHANGES.

No one of the various operations carried on by the Smithsonian Institution is of more importance in the advancement of science than that of the international exchange of publications between the governments and their bureaus, departments, the learned institutions, and scientific men of the two worlds. Notwithstanding the increase of the governmental international system, in which quite a number of nations have joined, the work of the Smithsonian Institution still continues to be of pre-eminent magnitude and importance. Originally initiated for the purpose of distributing the publications of the Smithsonian Institution to libraries, societies, and learned men abroad, and to receive returns for the same, it was gradually extended so as to take within its sphere all the establishments in the New World requiring a similar service. Indeed, by its system of agencies in various portions of the world to which packages were sent for transmission to destination, and where returns were gathered and forwarded to Washington, it maintained an arrangement of its own, entirely independent of any other organization.

If there has been any diminution of efficiency in the system of official exchanges during the last few years since the establishment of international bureaus by various national governments, owing to the absence of direct responsibility to the Institution which its service of paid agents secures, it is hoped and believed that as the routine becomes better understood and appreciated all requirements will soon be satisfactorily met.

Within a year or two by the reorganization of the service and an increase in its force, the department of exchanges of the Institution, now in charge of Mr. George H. Boehmer, has become very efficient, and to his report, herewith appended, I refer for more minute details.

It may be proper to remark that while the number of foreign addresses in communication with the Smithsonian Institution in 1850 amounted to 173, at the close of 1881 it forms an aggregate of 2,908, divided as follows:

Africa, 36.

America, exclusive of the United States, 135.

Asia, 68.

Australasia, 82.

Europe, 2,578.

Polynesia, &c., 9.

A detailed list of the parties in the United States sending and receiving the packages embraced in these transmissions will also be found in the Appendix.

The expenses of the service for the year, in consequence of an appropriation by Congress, have been reduced from \$9,996.05 in 1880, to \$7,467.84 in 1881.

It is very desirable that the entire cost of this system of exchange, so far as the actual expenses are concerned, should be defrayed by the government. So far as establishments other than the Smithsonian Institution are concerned, there is every reason why the government should pay the cost, and the propriety is still greater in reference to the exchanges of the Institution itself, since all the returns obtained are immediately transferred to the Library of Congress, of which they constitute a very important part.

The acquisition of many works, of great scientific and economical value, unpurchasable by money, is accomplished, first, by expenditures of the Institution for printing its publications, and then by their transmission through the system of exchange to various parts of the world, and the receipt of returns for the same.

The cost of the system of Smithsonian exchanges would be some thousands of dollars greater than is actually the case but for the continued liberality of the various steamship lines between the United States and other parts of the world. A list of these lines and of the general agencies through which transmissions are made is given in the Appendix.

Among the important additions made to this list during the past year, special mention should be made of the Red Star Line, of which Messrs. Peter Wright & Sons, of Philadelphia, are the agents. This line has carried a large number of packages between New York and Antwerp without charge. The Hamburg American Packet Company has also extended its privileges so as to cover a much larger range of material than heretofore.

For some years past there have been serious difficulties in the transmission of the exchanges of the Smithsonian Institution to Cuba, owing to onerous custom-house regulations, and an arrangement was finally made through the minister of Spain, Señor Don Felipe Mendez de Vigo, by which all our packages were to be addressed to the governor-general of Cuba and transferred by him, with the accompanying invoice, to Prof. Felipe Poey, of the University of Havana, by whom they are distributed.

The total number of boxes required to contain the transmissions for the year amounted to 407, of a gross bulk of more than 2,000 cubic feet, and a gross weight of over 100,000 pounds.

*Government Exchanges.*—In addition to the regular routine work of the exchange referred to above, the Institution has for several years past prosecuted, under Congressional enactment, an exchange of the publications of the United States Government for those of other nations, the transactions being exclusively between the Government of the United States and those of other countries. For this purpose fifty sets of all publications made at the expense of the United States, whether by order of Congress or by a department, are turned over to the Library of Congress for transmission to the Smithsonian Institution, and these are distributed to such nations as give corresponding publications in return. As the amount of material printed by the United States amounts to from 12 to 16 cubic feet every year, the aggregate transmissions are very important, and year by year the returns come in in an increasing proportion. The whole transaction is intended for the benefit of the Library of Congress, so as to secure the official publications of other nations, most of which can only be obtained by this system of exchange.

There is a curious feature connected with this distribution of public documents, namely, with the exception of two sets which are reserved by the Library of Congress for its use, there is no provision by which any American library can obtain anything like so complete a series of the official publications as are sent by the Institution to foreign governments connected with the Exchange. It seems very desirable that instead of reserving fifty sets only of each government publication, there should be at least one set reserved for the leading library of each State, or, at any rate, for that of the State and Territorial legislatures.

Reference has been made in previous reports to the establishment of a governmental system of international exchanges corresponding to that of the Smithsonian Institution. No important addition to the number of governments mentioned as concerned, has been made during the year 1881, although its extension to all the principal countries is much to be desired.

While the Smithsonian Institution has been named as the official agent in this business, its labors would be greatly facilitated if it could communicate directly with corresponding bureaus of other nations, the work, too, would be prosecuted much more satisfactorily. The governments of Russia and Italy, although not giving a formal adhesion to the system of the Smithsonian Institution, yet in the year 1881 established bureaus for the practical management of international exchange.

By the exchange convention of Paris in 1875, it was provided that each party sending should deliver its transmissions free of expense, in the office of the other; but the stipulation, so far as the transoceanic relationships of the United States were concerned, was extremely un-

satisfactory, on account of the great number of changes required between Washington and the foreign capitals. The Smithsonian Institution, therefore, endeavored, so far as its own business was concerned, to secure a modification of the proposition. It is a very simple thing for charges from one point to follow the goods and be paid for in a lump on receipt, while it is extremely difficult to know beforehand, or to prepay expenses not yet estimated or assessed. The modification proposed by the Smithsonian Institution was that each party should select its most convenient seaport for receipt and delivery and pay expenses to that point, or even to the port designated by the other; the remaining charges to be met by the recipient. The acceptance of this modification by the governments of Russia and Italy was delayed, but ultimately the matter was settled by making Hamburg the point of exchange with Russia, and New York with Italy, the Institution paying only the expenses to and from these two points.

For some years the exchanges of its publications made by the Department of Agriculture with foreign institutions have been interrupted, and a very important source of increase of its library thereby interrupted. Commissioner Loring, since his accession to the charge of the department, has expressed his desire to resume the exchange, and has made arrangements to carry it on upon a suitable scale.

Reference has been made to the action of Congress in making an appropriation for meeting, in part at least, the expense to the Institution of the system of international exchanges. A letter was addressed, on the 23d of October, 1880, to Hon. William M. Evarts, Secretary of State, calling attention to the cost to the Institution of continuing a work for the United States Government not properly chargeable to the Smithsonian fund. In a letter, of which a copy is given in the appendix, Mr. Evarts expressed his appreciation of the plea, and announced his intention of asking Congress for relief. An estimate of \$7,000 was sent in by him for this purpose, but the sum of \$3,000 only was granted. This, however, as stated, has been a very material help, and it is hoped that a larger allowance will be made for the present fiscal year, an estimate for which has been presented.

As this work is prosecuted for the benefit of the country at large, and especially for that of the various bureaus of the United States Government, there is no reason why the actual expense should be a charge upon the income of the Smithsonian Institution, which has so many other calls upon it. Whatever sum can be saved in one direction can always be usefully applied in another in the interest of science and of general education.

A history of the exchange system since its origin has been prepared by Mr. G. H. Boehmer, and is presented in the appendix to this report, together with a portion of the official correspondence between this Institution and the department relative to the project of international exchange initiated by the Geographical Congress held in Paris in 1875,



and since carried out by the concurrence of most of the European nations.

#### DISTRIBUTION.

Closely connected with the department of exchanges is that of the distribution by the Smithsonian Institution of books and specimens on its own account and that of the National Museum. As has already been shown, the entire system of International Exchanges of the Institution began in the desire to find a convenient method of distributing its own publications to libraries and societies and a provision for the receipt of returns. On getting the machinery of distribution fairly at work it was found sufficiently comprehensive to serve other establishments in the United States, and little by little it grew to its present magnitude.

*Distribution of Books.*—The distribution by the Institution on its own part consists mainly of copies of the Annual Reports of the Regents of the Institution to Congress, and the various publications included in the Smithsonian Contributions to Knowledge and the Miscellaneous Collections, both in their separate form and as aggregated in volumes. More recently the Proceedings and Bulletins of the National Museum have been added to the number of volumes to be sent out. The distribution through the United States, however, by a law of Congress is now made under a frank of the Smithsonian Institution, which also covers the Dominion of Canada. That to foreign countries is made either by mail or by the various agencies of transportation.

As in previous years, the oceanic shipments are made almost entirely without expense, as explained more fully in another part of the report.

The Pennsylvania Railroad and its dependencies and the Baltimore and Ohio Road have continued to make important reductions in their rates of charges to Baltimore, Philadelphia, and New York.

*Distribution of Specimens.*—The distribution of specimens, either in the way of exchanges for other articles or as donations to the museums of colleges, academies, &c., has continued during the year on a very large scale. The details of this will be found under the head of the operations of the Museum.

#### LIBRARY.

As in most other branches of Smithsonian operations, the accessions to the library show a continued increase, the numbers of books and other publications received during the year as compared with those of the three preceding years being indicated in the accompanying table. This does not include the special contributions to the working library of the National Museum, which have not been fully catalogued, but will be reported upon hereafter.

As is well known to the Board, the books received by the Smithsonian Institution, either by way of exchange or donation, are transferred to the Library of Congress, in which they constitute a very conspicuous feature; representing as they do an extensive series of transactions and memoirs of societies and scientific and technical publications.

*Statement of the books, maps, and charts received by the Smithsonian Institution and transferred to the Library of Congress.*

	Quarto or larger.			Octavo or smaller.				Total.
	Vols.	Parts.	Pamph's.	Vols.	Parts.	Pamph's.	Charts.	
1878.....	403	2,620	463	860	2,356	1,953	74	8,729
1879.....	440	2,612	591	1,509	3,240	1,628	183	10,203
1880.....	337	2,603	477	806	2,577	1,618	152	8,570
1881.....	762	3,914	468	1,105	3,591	1,931	188	11,959

As part of the statistical work of the United States Census, a complete file of all the newspapers published in the United States during the census year of 1880 was collected, the total amounting to some five thousand titles. The authorities of the Census Department offered these to the Smithsonian Institution if it could find proper accommodations for the same. As, however, the library of the Institution has long since been merged in that of Congress, and as the expense of binding alone would have been extremely onerous, the suggestion was made that the whole be offered to Mr. Spofford.

### THE NATIONAL MUSEUM.

The organization of the National Museum may now be regarded as practically completed, and the arrangement of a large portion of its valuable material for instructive display at least provisionally effected. A very full report of the scientific objects aimed at and of results so far accomplished in this important branch of the public service has been prepared by Mr. G. Brown Goode, the assistant director in charge, and will be found in the appendix.

Reference was made in the reports for 1876 and 1877 to the enormous amount of material presented to the United States by exhibitors at the Philadelphia Centennial, and to the number of car-loads transferred to Washington. Since the completion of the National Museum the greater portion of these specimens have been removed from the Armory and subjected to a provisional arrangement, precedent to their final assignment to the cases.

The minerals and ores were unpacked under the direction of Dr. Hawes, in charge, and the reserve series picked out and held in readiness for further action. The duplicates have all been properly assorted, and to some extent distributed. This work however, cannot be satisfactorily carried out until the coming year.

The purely metallurgical specimens have also been classified; but are still, for the most part, in their boxes, awaiting the appointment of a specialist for that department.

*Increase of the Museum.*—It has been reported to the board that at the close of the International Exhibition a company was organized in

Philadelphia for the purpose of continuing the display for an indefinite period. The great main building, covering 18 acres, was purchased at a very low price, and from among the original exhibits many were either purchased by the company or presented, or deposited by the proprietors. Numerous additions were also made, in certain specified directions, the object being to have a display of industries, for commercial purposes, and also for the general education and instruction of the community.

The anticipations of the projectors of this exhibition were not realized, the distance of the building from the city and the length of time necessary to visit it, and the satiety of the public in regard to such displays caused the number of visitors to fall far below what was necessary to meet the expenses, and after struggling vainly against the inevitable, the exhibition was given up and the building sold. The owners of property therein were notified to remove it at the earliest possible moment.

As there was much in this exhibition that fell entirely within the plan of the industrial department of the National Museum, Mr. Thomas Donaldson was requested to act as an agent for soliciting contributions, which he did with such success that, by far the greater part of what was really valuable and important, was obtained by him as a free gift from the proprietors. Several months were spent, with a proper corps of assistants, in taking down and packing the exhibits for transportation, and the entire mass is now stored in a temporary warehouse, awaiting an appropriation by Congress for transfer and installation.

A detailed list of these donations will be appended to this report. Their money value is estimated at not less than \$150,000. In addition to the collections actually obtained, many others are promised, and are now, for the most part, in process of preparation.

*Medicinal Collections.*—As indicated in previous reports, a full collection of the materia medica of the world has been projected as one of the exhibits of the National Museum. In addition to the large amount of material of this character obtained at the International Exhibition of 1876, the Institution received the promise of aid by Messrs Schiefelin & Co., of New York, a very prominent firm, connected with the drug trade. The firm sent a representative to the International Pharmaceutical Convention, held in London during the past summer, with special reference to obtaining certain obscure and unusual substances that could not otherwise be secured. Many hundreds of varieties of great rarity resulted from this mission. As especially related to the medical department of the Navy, Surgeon-General Wales detailed Dr. J. M. Flint, assistant surgeon, U. S. N., to take charge of this division of the Museum, and he is now engaged in cataloguing and labeling the specimens as they are received.

In order to obtain the necessary information on this subject, the

Smithsonian Institution, through the courtesy of the State Department, has issued circulars to the foreign representatives of the United States, asking first, whether there is a national pharmacopœia in the country to which accredited, and second, requesting that copies if published be sent to the Institution. Responses have very generally been received, and a very complete collection of pharmacopœias is at present in Doctor Flint's possession, from which to prepare the list referred to.

*Special Contributions.*—The explorations of the United States Fish Commission have added greatly to the material at the command of the Smithsonian Institution, both for research and distribution. The many new and rare species of fishes collected by the commission constitute a very important advance in our knowledge of the deep seas. Besides enriching the National Museum, the large mass of duplicate specimens will enable the Institution to continue its distribution of labeled suites of species to a large number of educational establishments in the country.

Prof. Felipe Poey, of Havana, furnishes a supply of living reptiles for the use of the modelers, and also rare fishes, types of many new species described by himself.

Mr. Livingston Stone has furnished large important collections of fossils as well as of recent animals, from the United States Fish hatchery, on the McCloud River, California, a region of very great ethnological and zoölogical interest.

Hon. John M. Langston, United States minister to Hayti, has contributed some valuable collections of the corals of the islands, quite a number of which were new to the collection.

Mr. C. C. Leslie, an extensive fish dealer of Charleston, S. C., has continued his collections in the line of ichthyology from the shores of his State.

Mr. Silas Stearns, a fish dealer in Pensacola, has also added materially to the very large number of fishes of the Gulf of Mexico, previously presented by him. To Mr. Stearns we are indebted for quite a number of entirely new species, which have been or will be described in the proceedings of the National Museum.

In addition to the collections of fishes and marine invertebrates by the main parties of the United States Fish Commission, Col. M. McDonald, in charge of the station for hatching Spanish mackerel at Cherrystone, in Chesapeake Bay, made a large collection, embracing many rarities.

In the earlier volumes of the reports of the Institution frequent mention is made of contributions to the National Museum by Mr. R. MacFarlane, of the Hudson Bay service, while stationed at Fort Yucon, Fort Anderson, and elsewhere; and even to the present time the early collections of Mr. MacFarlane stand pre-eminent. To him is due more

than to any single person, the knowledge which we have of the natural history and ethnology of the arctic circle of North America.

Since Mr. MacFarlane's change of station to an interior post he has been prevented from making many additions to his series; but during the year 1881 we were gratified at the receipt of a number of skins of rare mammals, &c., contributions by him, and showing the persistency of his interest in the National Museum.

Dr. James Moran, of the Medical Department of the Army, who furnished collections in previous years, has also supplied several rare forms of pottery and other aboriginal remains from Arizona.

Miss Rosa Smith has continued her contributions of fishes from San Diego, Cal. supplementing to some extent the work prosecuted there in 1880 by Prof. D. S. Jordan, as referred to in the preceding portion of this report.

Mr. James G. Swan, of Port Townsend, Wash. Terr., whose contributions to the ethnology and general natural history of Puget Sound, have been noticed in almost every report for twenty years, has not intermitted his exertions during 1881. Numerous collections of objects of Indian manufacture, of fishes, &c., have been received from him with a large amount of special information on the fisheries of Puget Sound.

Mr. José Zeledon, of San José, Costa Rica, to whose services as a skilled ornithologist and collector reference has frequently been made, has added to his many contributions by supplying some extremely rare and possibly new species of birds of Costa Rica.

#### ETHNOLOGICAL BUREAU.

The Ethnological Bureau, established by Congress for prosecuting researches among the Indian tribes of North America, with the view of securing to ethnological science available records of races destined ultimately to disappear, is continuing its interesting and important work, under the able directorship of Major Powell, with marked and gratifying success. The most important of these operations during the past year consists of the work of Mr. F. H. Cushing, and that of Mr. James Stevenson. Mr. Cushing has been a resident of the village of Zuñi for several years past, carrying his researches into the domestic habits, religious rites and ceremonies, and other features of the condition of the Pueblo Indians of New Mexico, and he has obtained a vast body of original information upon these subjects, which will, in time, be published. He has made very large collections in ethnology, those obtained in the caves of New Mexico being especially noteworthy. A peculiarity in the religious observances of the Pueblo Indians consists in their hiding away a memento of important ceremonials, in caves accessible with great difficulty, and only visited on such occasions. The accumulations in these caves date back many years, and the specimens gathered, illustrating the changes in methods and chronological peculiarities, are very interesting.

Similar collections have been received through Mr. Metcalfe from a cave near Silver City, N. Mex., showing a similarity of treatment of the subject over a wide extent of the country.

At the last session of Congress the sum of \$5,000 was especially reserved, by enactment, from the appropriation for ethnological researches to be expended in continuing investigations into aboriginal mounds, and several gentlemen were assigned to this business. The most important contributions under this arrangement have been made by Dr. Edward Palmer, who has spent several months in Tennessee, and subsequently in Arkansas. A large number of boxes have been received from him, containing some extremely rare and even unique objects.

Dr. W. De Hass was assigned to a certain region in West Virginia and adjacent portions of Eastern Ohio. This work has been prosecuted during the summer, but as yet no collections have been received.

Mr. W. J. Taylor, of Nashville, Tenn., has furnished a number of specimens similar in character to those of Mr. Palmer.

Mr. S. T. Walker has also procured some mound relics from Florida. His collections are all very interesting, as showing some peculiarities in the contents of prehistoric mounds and graves in that State as compared with those of Tennessee and Arkansas.

Ethnological and archæological explorations, heretofore conducted by the Bureau of Ethnology in the Northwest, under the direction of Professor Powell, were continued over contiguous areas to those examined the two previous years. The vast quantities of valuable material, both ancient and modern, possessed by the Pueblo tribes made it important that the work of collecting should be carried on extensively, in order to secure as much as possible, before they were carried away by visitors and speculators, who are now, since the railroads make that region accessible, visiting that country frequently. A party was equipped and placed in charge of Mr. James Stevenson to prosecute the work among the Indians of the Province of Tusegan, known as the Seven Moquis, and also to secure an additional collection from the Pueblos of Zuñi. The party proceeded to each of these localities, from which large and varied collections were made, consisting of everything pertaining to the religious and domestic life of these tribes. The collections from Moqui are unique and valuable, consisting of a large number of ancient earthenware vessels and stone implements. Among the former are some very handsome vases elaborately decorated with unknown designs, and of new forms in structure from any hitherto found. The tribes from whom they were obtained had no knowledge of their origin, but they were in all probability made by the people who resided in a village of considerable dimensions, about twelve miles east of Moqui, called by the Navajos Tally-hogan or singing houses. An examination of this village, which is now in ruins, revealed immense quantities of fragments of pottery, on all of which were designs and figures, similar to those on the ancient vessels just referred to, which were obtained from the Mo-

quis. The amount of material secured from Moqui was quite large, aggregating about 12,000 pounds. A map of great accuracy was made of the seven villages, and will accompany the report of the Bureau to show the relative positions of the villages of this province.

The collections from Zuñi were large and important, amounting in weight to 21,000 pounds.

Mr. Mendelev, with several assistants, completed a survey of Zuñi for the purpose of constructing a model of the village on a scale of five feet to the inch. This model was completed during the present winter, and is now on exhibition in the National Museum. The area covered by Zuñi is 1,200 by 600 feet, not including the goat and sheep corrals and gardens, which occupy a much larger area. The model, however, will illustrate all those features. The preparation of this model (which includes several thousand details) by Mr. Mendelev required much labor and skill. It is prepared in papier-maché, and presents the true colors of the village as well as all the details.

During the season, Mr. J. K. Hillers, the accomplished and skillful photographer of the survey, in addition to the geographical and geological illustrations made by him, secured a large number of finely executed photographic views of all the Moqui villages and of Zuñi, as well as of many ruins in the region surrounding them, among which are many character sketches of the people, interiors of their houses, eagle pens, corrals, portraits of men, women, and children, also many views of the people while in the attitude of baking pottery, drying meat, dancing, &c. The work was not completed; it is therefore contemplated to make further and more exhaustive researches in these regions in the future.

Some years ago the Smithsonian Institution had two Indians, one named Tichkematse, a Cheyenne, and the other Geo. Tsaroff, a native of the Aleutian Islands, in charge of the ethnological hall. The presence of these Indians in the room attracted much attention, especially as they were able to explain intelligently the functions of many of the implements and other objects from a personal acquaintance with their use. As stated in the last report, Tsaroff died of consumption in 1880, and Tichkematse returned to his tribe in the Indian Territory, where he exercised, in the interest of the Smithsonian Institution, his abilities as a taxidermist. During the past season, at the request of Mr. F. H. Cushing, he was ordered to Zuñi, and rendered very important service as an assistant in making ethnological collections under the direction of Mr. Cushing and of Mr. James Stevenson.

#### CO-OPERATION WITH OTHER ESTABLISHMENTS.

*Pacific Mail Steamship Company.*—Among the earliest establishments to co-operate with the Smithsonian Institution in its work of exploration and exchange was the Pacific Mail Steamship Company; and during the past year the Institution has been indebted to the president and officers

for important courtesies. Capt. John M. Dow, the resident agent of the company at Panama, has continued to be of the utmost service to the Institution, not only in transmitting valuable collections, but also in taking charge of packages of books and specimens to and from the Institution. At his suggestion the president of the company has kindly offered the facilities of the line to any explorer we may wish to send to investigate the natural history, and especially the ichthyology, of Central America. Arrangements will be made in the coming year to take advantage of this desirable offer.

*Corcoran Gallery of Art.*—One of the departments of the Smithsonian Institution, as designated by the act of incorporation, was the maintenance of a gallery of art. On the establishment of the Corcoran Art Gallery, with ample funds for the acquisition of paintings, engravings, and statuary, and suitable accommodations for their display, the Regents, under the authority vested in them by Congress, authorized the transfer to that establishment of the collections of the art gallery; and at present there is but little of importance in the Smithsonian building, especially since the delivery to the Library of Congress of the valuable collection of engravings purchased some years ago by the Institution from the Hon. George P. Marsh, at present United States minister to Italy. The Institution, however, still retains the series of busts in plaster and marble of eminent historical personages of both the Old and the New World.

Most of the objects in the art department were derived from the collections of the National Institute for the Promotion of Science, an organization which, after twenty years' existence, expired by limitation of charter, in accordance with which its property, in specimens, books, &c., was turned over to the Smithsonian Institution. Among the paintings transferred was a full-length portrait of General Washington, painted by the late Mr. Charles W. Peale. By authority of a law of Congress this was sent to the International Exhibition of 1876 in Philadelphia, and arranged with the other art collections. It was subsequently transferred to the halls of the Academy of Fine Arts in Philadelphia. It was, however, reclaimed by the Institution during the past year, and placed in the Corcoran Art Gallery, where it now remains. The ownership of this picture is claimed by Mr. Titian R. Peale, a son of Mr. Charles W. Peale, its painter, and his claim for compensation is now before Congress.

**TREASURY DEPARTMENT.**—*Revenue Marine.*—Reference has already been made to the co-operation of the Treasury Department in the scientific work of the Institution, in instructing Captain Hooper to take Mr. Nelson on board the "Corwin" for the special purpose of making an investigation of the ethnological peculiarities of the natives of St. Lawrence Island. In many other cases the revenue marine has rendered essential assistance to science by its co-operation. Many valuable



specimens have been received from the officers, especially from Capt. C. M. Scammon, Captain Hodgden, Captain White, Capt. J. G. Baker, Captain Howard, and numerous others. Indeed, there is scarcely an annual list of contributions to the National Museum that does not embrace a donation of greater or less magnitude from that office, and the archives of the Smithsonian Institution have further been enriched by valuable communications on natural history and ethnological subjects.

As another example of co-operation, mention may be made of the help extended by the Institution to the two Doctors Kraus, gentlemen sent to America in the early part of the year 1881 by the Geographical Society of Bremen for the purpose of carrying on ethnological and biological researches on the Asiatic shores of Behrings Straits. Commended to the Institution by Dr. Lindeman, and others, letters of introduction were furnished to persons in San Francisco, and a permit was obtained from the Secretary of the Treasury authorizing the shipment of ammunition and supplies for making natural history collections. The Smithsonian Institution also furnished a quantity of alcohol for the preservation of fishes and marine invertebrates.

These gentlemen embarked on a schooner at San Francisco, and were last heard from at St. Lawrence Bay in Siberia. At that time they had secured quite a number of specimens, and were prosecuting their researches among the Tschuchas.

*The Coast and Geodetic Survey*, also a bureau of the Treasury Department, has continued its favors in authorizing the officers in charge of shore parties or of hydrographic work to utilize any convenient opportunity at their command in collecting specimens for the National Museum. Very valuable collections were made during the year by Commander Nichols, in charge of the Coast Survey steamer "Hassler." These embraced fishes and reptiles from Mazatlan and elsewhere, along the coast of Lower California, from Upper California, and from Alaska. Quite a number of new species of fishes have already been described from this collection.

In previous years many contributions were made by Lieut. Wm. P. Trowbridge, Mr. Wm. H. Dall, and others of the Coast Survey, which are among the most important accessions to the National Museum.

In this connection it should not be forgotten that the recent explorations by Mr. Alexander Agassiz, in connection with the physical and natural history of the South Atlantic and the Gulf of Mexico, have been made under the direct patronage of the Coast Survey, and that the first series of all collections, embracing many new and rare species, are, by law, the property of the National Museum.

*The Light-House Board* of the Treasury Department has also continued its aid. This has been extended more particularly in the way of instructions to keepers of light-houses and light-ships to make observations in regard to the temperature of the air and of the water and of the occurrence of the phenomena of migrations of marine animals. With

the help of thermometers furnished by the Fish Commission or the Signal Office, a valuable body of material has been obtained, throwing important light on the movements of fish in relation to their physical surroundings.

## NECROLOGY.

During the year 1881 I have to report the loss by death of two among the employés of the Smithsonian Institution; one of these, Mr. JOHN H. RICHARD, which took place at Philadelphia on the 18th of March; the other, Miss MAGGIE CONNOR, at Washington, on the 20th of November. Mr. Richard was a Frenchman by birth, but a resident for many years of this country, and for a long time occupied a prominent position among natural history draughtsmen. Originally employed by Professor Holbrook in the preparation of the plates of his great works on the reptiles and fishes of South Carolina, he entered the service of the Smithsonian Institution nearly thirty years ago, and was employed for many years in making illustrations of reptiles and fishes for the reports of the Pacific Railroad, the Mexican Boundary, the Wilkes Exploring expeditions, &c. Resigning his position, he for some years engaged in business in Philadelphia as a colorist, still doing more or less work for the Institution. Subsequently he resumed his old situation, and for seven or eight years he has been principally employed in painting casts in plaster and papier-maché of American fishes and cetaceans, the white work having been done under the direction of Mr. Joseph Palmer. The excellence of these representations has been universally commended, especially as exhibited to the general public at the International Exhibition in Philadelphia and the Fishery Exhibition in Berlin. The death of Mr. Richard leaves a gap among the capable natural-history artists of this country.

Another death among the employés of the Smithsonian Institution was that of Miss MAGGIE CONNOR, who died of consumption on the 20th day of November. Her father was one of the earliest employés of the Institution and died in its service, and Miss Connor has been for many years connected with the record department of the Museum.

It is, perhaps, proper to mention also the death of Mr. George W. Riggs, on the 25th day of August, a gentleman who, although not at the time immediately associated with the Institution, had long been its financial agent, and who has rendered many very important services in connection with his profession as a banker.

## MISCELLANEOUS.

For many years Mr. Townend Glover, both before and during his connection with the Department of Agriculture, was engaged in preparing and in engraving on copper, in time outside of that due to the department, a series of illustrations of the economical entomology of the United States, until failing health and the almost entire loss of eyesight pre-

vented his further action. He had, however, engraved many hundreds of plates, illustrating the life history of the insects most prominent as beneficial or injurious to the farmer. Professor Glover published a portion only of this work, printing at his own expense the text and illustrations. He has been desirous of obtaining help from the government to issue the complete work, but so far has been unable to secure the necessary appropriation, although the subject has been warmly recommended by several of the committees on agriculture. Finding it necessary to remove to Baltimore, he has deposited all his plates in fire-proof apartments of the Institution, subject to further action. It is very desirable, in the interest of the farmer and horticulturist, that this work should be published at an early date, and the immense mass of practical information made available.

It has been the custom of the Smithsonian Institution to give to eminent American men of science letters to its foreign correspondents, commending them to any official attentions that may be convenient, and requesting for them the privileges of libraries and museums. During the year 1881 such letters were given to Dr. J. S. Billings of the Medical Department of the Army, a member of the National Board of Health, who visited Europe on official business connected with the latter establishment, and to Dr. Durgin, President of Hillsdale College, Michigan.

#### INTERNATIONAL EXHIBITIONS, ETC.

Reference was made in the report for 1880 to the part taken by the National Museum and the United States Fish Commission in the International Fishery Exhibition, held at Berlin in the spring of 1880. The collections sent to Berlin have all been returned and restored to their places. The reports of this exhibition by various foreign countries have been received, and all unite in referring to the display made by the National Museum and Fish Commission as being by far the best and most instructive of all, this being corroborated by the receipt of the highest awards. The grand prize, a silver gilt vase of beautiful design and of great cost, was made personally to your Secretary as head of the United States Fish Commission, and an act of Congress was passed authorizing him to receive it free of the duty, which alone would have amounted to about one thousand dollars. He has presented it to the National Museum, of which it will doubtless constitute an attractive object.

A second exhibition in which the Smithsonian took part was that of the International Electrical Convention, held in Paris in August, 1881.

A series of the publications of the Institution, relating to electricity, was transmitted and placed in charge of the American commissioner, Hon. George Walker. The appreciation by the jury of the services of Professor Henry to electrical science by his discoveries and of the Institution by its publications was shown by the grant of one of the highest

awards, namely, the Diploma of Honor. The American representatives at the exhibition were Mr. Walker, commissioner-general, Prof. George F. Barker, commissioner expert, &c.

The occasion of the International Electrical Congress in Paris during the past summer was embraced by the French Government for bringing together a commission in relation to the forthcoming transit of Venus, and, at the request of the State Department for a nomination of an American known to be in Paris, the name of Prof. G. F. Barker was suggested by the Institution as a suitable representative on the part of the United States. Although not an astronomer, Professor Barker is well known as a most accomplished physicist, and able to take part in any general discussion of matters and system of co-operation.

*International Congress of Americanists.*—An international association devoted to recovering data in regard to the early history of the Americas has for many years held its sessions annually in the different capitals of Europe, that for 1881 being held at Madrid, under the special patronage of His Majesty King Alfonso. The Smithsonian Institution was invited to take an interest in this association by collecting subscriptions and issuing tickets of membership. The proceedings of the meeting have not yet been published. It has been suggested that an invitation be extended by the President of the United States to have one of the forthcoming meetings of the association held in this country, and that the hospitalities of the nation be extended by an appropriation by Congress for the expenses of oceanic travel. This matter will probably come up for the consideration of the government at the proper time.

*International Geographical Congress.*—Another international convention which took place during the summer was that of the Geographical Congress at Venice. The publications of the Smithsonian Institution and of the United States Fish Commission, as far as they bear upon geographical explorations and discovery, were presented, and the United States was ably represented by Capt. George M. Wheeler, United States Engineer, a gentleman well known for the magnitude and importance of his explorations under the War Department.

#### EXTERNAL RELATIONS OF THE SMITHSONIAN INSTITUTION.

The Smithsonian Institution occupies a somewhat peculiar position in its general relationships. Provided by the liberality of a foreigner with funds for carrying out its own special work, and charged by the government with additional duties, for which means are provided by Congress, it has relations on the one side to private or special establishments, and on the other to those of the home and foreign governments.

In its purely Smithsonian operations, it may be designated as exercising all the functions of a great society, such as the Royal Society of London, the academies of St. Petersburg, Berlin, Vienna, &c., without any members, the work being done by a purely official bureau. In one relationship or another it publishes results; it superintends a great museum and library and gallery of art; it maintains a laboratory; it conducts a system of international exchanges, in which its associates are directly in communication with bureaus of foreign governments. For the United States Government it supervises the National Museum and the international system of exchanges. It also acts in a measure as a scientific adviser of the government in receiving questions for solution, making chemical and other investigations of material, nominating experts or agents, in connection with scientific work, &c., its facilities being always at the command of either Congress or the departments.

## UNITED STATES FISH COMMISSION.

### ITS GENERAL OBJECTS AND RESULTS.

My appointment, at the commencement of its operations in 1871, to the charge of the United States Fish Commission, has rendered it expedient to give some account of its operations year by year in the annual report of the Smithsonian Institution.

Although commencing in the year mentioned on a very small scale, the demands of the public and the will of Congress have caused a notable extension each year, until at the present time the commission constitutes a very important factor in the operations of the government, fairly comparable, so far as the food problem is concerned, with the Department of Agriculture.

The two branches into which the work of the Commission is divided, namely, that of the investigation of the condition of the fishing and the fisheries, and the propagation of food fishes, have been explained heretofore, and with especial fullness, in the report of the Institution for 1880, so as to render it unnecessary to go into the same detail at the present time.

For the purpose of continuing the investigations into the condition of the fisheries, Wood's Holl—the locality where the first work of the Commission was begun in 1871, and continued in 1875—was selected. This point of the coast offers exceptional advantages as a center of investigation, mainly owing to the conveniences placed at the service of the Commission by the Light-House Board, in the form of a suitable building for a laboratory and store-room, and wharfage for the small boats. The waters in the vicinity are also exceptional in their purity and in the abundance of animal life; and the point itself is central, permitting ready departure to any desired locality.

As in 1880, the "Fish Hawk," the hatching steamer of the Commis-

sion, was used for the off-shore researches and in her complete equipment of apparatus answered every demand. The vessel was still in command of Capt. Z. L. Tanner, an accomplished naval officer, who was not only competent to take charge of the vessel in all matters of detail, but by his thorough knowledge of mechanical appliances, and his inventive powers, was able to devise many very important improvements in the machinery necessary for carrying on the work.

The officers and crew of the vessel were supplied, as before, by the Navy Department, in accordance with the law of Congress. The only change in the detail of officers was the replacing of Engineer Boggs by Engineer Bailey.

Fuller reference will be made in another part of this report to the work of the "Fish Hawk" in connection with the hatching of food fishes. The vessel was first employed in this capacity in Albemarle Sound, and afterward in the Susquehanna River, two of the stations for the propagation of shad. She afterward proceeded to Chesapeake Bay and engaged in experiments looking towards the artificial propagation of the Spanish mackerel.

During the two previous seasons of occupation of the Wood's Holl station by the Fish Commission a very thorough investigation was made of the inshore localities, the whole of Vineyard Sound, Buzzard's Bay, and other adjacent portions having been thoroughly explored in the "Blue Light" and other smaller vessels; it was therefore determined to continue the work commenced at Newport in 1880 along the eastern edge of the continental plateau representing the hundred-fathom line. This plateau, as has been explained in previous reports, extends along the Atlantic coast of the United States to a distance, for the most part, of from 75 to 100 miles, being however considerably narrower off Cape Hatteras. The depth of water increases very gradually to one hundred fathoms, not much faster in most cases than one fathom to the mile, affording a level almost equal to that of a western prairie. On reaching the limit, however, the descent is very abrupt, sometimes amounting to 1,000 fathoms, or considerably over a mile, in a few miles. Along the edge of this precipice animal life occurs in vast profusion, both as to the number of individuals and of species, thus furnishing a very interesting field of research in the matter of general natural history, as well as in regard to the occurrence and distribution of valuable food fishes.

The first cruise of the "Fish Hawk" to this ground in 1881 was made on the 15th July, followed by others at intervals of about once a week through the summer. As the "Fish Hawk" had been built for inshore work, and not with reference to standing rough weather outside, it was, of course, necessary to watch carefully the opportunity of slipping out under favorable auspices, the dredge and trawl not being capable of being used to advantage in a rough sea.

Very valuable service was rendered by the Signal Office in Washing-

ington in this connection by furnishing information as to expected storms in advance of their publication in the daily newspapers. The vessel usually started out in the afternoon of one day and reached the desired ground by daylight of the following morning ; then, after spending the day in dredging, returned the next night, reaching its berth the following morning, or usually after an absence of from thirty-six to forty eight hours.

The work in the laboratory at Wood's Holl commenced on the 8th July and continued until the middle of September. I remained until the 4th October, after which I returned to Washington.

As in previous years, Prof. A. E. Verrill, of Yale College, had charge of the collections and researches into the invertebrates, assisted specially by Mr. Richard Rathbun, Mr. Sanderson Smith, Mr. B. F. Koons, and Mr. E. A. Andrews. Prof. L. A. Lee, of Bowdoin College, Maine, as a volunteer, rendered essential aid.

The fishes were in charge of Dr. T. H. Bean, of the National Museum, assisted by Mr. Peter Parker, of Washington.

The results of the season's work were very satisfactory.

The locality of the tile-fish ground—the new food fish discovered within the last few years, and referred to in a previous report—was revisited, and numerous specimens obtained for the purpose of testing their eatable qualities. Other species of rare fishes—quite a number new to science—were secured. Very large collections of invertebrates were made, including many of great rarity, as well as a number of undescribed species, while abundant material was obtained in all departments for distribution by the Smithsonian Institution to colleges and academies throughout the country, and for exchange with foreign museums.

The "Fish Hawk" made some interesting deep-sea collections on her return to Washington, where she arrived in the early part of October. Her services were again called into requisition in the celebration of the capture of Yorktown, having been tendered to and accepted by the Secretary of War for his special service and that of his staff.

As usual at the summer stations of the Commission, there were numerous visitors at Wood's Holl during the summer, among them several naturalists, who desired to make special investigations in their respective branches.

The fact that the entire coast of the eastern United States from the Bay of Fundy to Long Island Sound has now been thoroughly explored by the Fish Commission, and the geographical distribution of the various species of marine animals ascertained, renders it desirable to fix permanently upon a station where the necessary appliances for storage of material for fitting out the exploring vessels can be kept, and where investigation of the animal life can be prosecuted to the best advantage, and also from which easy access can be had to any part of the North Atlantic Ocean. Believing that all these requirements are met at

Wood's Holl, and finding that the accommodations so liberally furnished by the Light-House Board would not be sufficient for the enlarging scale of work, I was able to make provisional arrangements during the summer looking towards the erection of a station in the Wood's Holl great harbor.

The great harbor of Wood's Holl, although somewhat obstructed by rocks, is yet capable of being made, at moderate expense, one of the most important of those on the coast, being the only one between Newport and Provincetown in which vessels of large draught can enter and be secure against storms from any quarter. There are several shoal-water harbors within the district mentioned, which are, however, usually untenable during storms from a particular direction. A vessel, however, once in Wood's Holl harbor is perfectly safe from any danger from storm.

One of the obstructions to the practical use of the harbor for this purpose is a reef running out to a considerable distance from the north side. Upon this vessels are liable to be wrecked, and the idea of having this obstacle removed has frequently been entertained by persons interested. The expense, however, would be very great, and it was found to be much cheaper to mark the reef by a pier built over it, and in so doing protect the only vulnerable part of the inner harbor from the swell coming from the south, thus assuring entire security to vessels behind it. As this work, besides being greatly in the interest of commerce, promised to meet all the requirements as a wharf for the vessels of the United States Fish Commission, it was determined to obtain, if possible, the adjacent land for the purpose of erecting the necessary buildings, and as it is practically very difficult to secure an appropriation from Congress to buy land, several parties agreed to furnish the funds necessary to purchase this land and present it to the United States. A provisional agreement was therefore made with the proprietors to sell the adjacent shore in the event of an appropriation being made by Congress for the engineering work.

In connection with the pier it is proposed to construct basins for the reception of fish, in which they can be penned until their eggs are ripe enough to be removed and treated artificially. I trust that I may be able in the report for 1882 to chronicle the successful accomplishment of these various measures and the actual working of the station.

The second branch of the work of the Fish Commission—that of the hatching of fish—has been carried on during the year with increasing and eminent success.

The first division of the work to be mentioned is that relating to the carp, a food fish, the best varieties of which were first introduced into the United States by the United States Fish Commission, and have been distributed very extensively to all parts of the country during the year. The principal station of production is in the ponds in the vicinity of the Washington Monument, in Washington City, and from them many



thousands have been sent out through all parts of the United States, this work being done either by shipments in passenger trains under the direction of messengers, or by car loads. Much apprehension of loss was excited by the ice gorge of the Long Bridge, at Washington, on the 12th February, 1881, by which the waters of the Potomac were backed up so as to completely flood the carp ponds. Fortunately, however, the grounding of the floating ice on the exterior limits of the ponds seemed to have the effect of preventing the fish from escaping; at least, careful examinations induced the belief that no considerable number had been lost.

The collecting of the eggs of the shad, and the hatching out and distribution of the young fish, were also carried on throughout the year on a very large scale. The three principal stations were Albemarle Sound, the Potomac River, and the Susquehanna. The "Fish Hawk" was first dispatched to Avoca, Albemarle Sound, passing through the Chesapeake and Albemarle Canal, for the purpose, arriving the end of March. The steamer "Lookout," in charge of Lieutenant Wood, was also dispatched to Albemarle Sound in March, and the two vessels were engaged for several weeks in the operation of hatching shad; after which work was transferred to the Potomac River. By the courtesy of the Navy Department and the authority of the commandant of the navy-yard, the principal station was made in the boat-house of the yard, to which the eggs were brought by the "Lookout" from the seine-hauling localities down the river. The "Fish Hawk" was engaged also for a time on the Potomac in similar work. Battery Island, on the Susquehanna, was also utilized in a like connection, and many eggs hatched out both there and on the "Fish Hawk", which was for the greater part of the time anchored some miles distant, in the northeast run. The shad thus obtained were sent into almost every State of the Union, and very greatly to the satisfaction of the inhabitants. The total number distributed amounted to many millions.

As in previous years, the obtaining and distributing of eggs of the California salmon were also carried on on a very large scale at the station on McCloud River in California. Many millions of eggs were distributed throughout all parts of the United States, and a number sent to foreign countries in response to official requests to that effect. As usual, several millions of the young fish were hatched and planted in the Sacramento River for the purpose of keeping up the supply. The hatching station itself had been destroyed by flood during the previous winter, but a special appropriation having been made by Congress for rebuilding it, the money was received in time to make the station available for this purpose.

The collecting of eggs of the Atlantic salmon was continued, as heretofore, at the station near Bucksport, on Penobscot Bay, in Maine, and the eggs obtained were distributed, for the most part, to State fish commissioners, to be hatched out and planted at their discretion.

The work connected with the land-locked salmon was continued at Grand Lake Stream, and many eggs secured.

The multiplication of white fish constituted, for the first time, an important branch of the labors of the Commission. For this purpose a station was established at Northville, Mich., under the charge of Mr. Frank N. Clark, who obtained the eggs required in the Detroit River, Lake Erie, and Lake Huron. Some 18,000,000 of eggs were secured and distributed, and nearly all were returned to the waters from which they were originally taken. Some were sent to various smaller lakes, and a few to localities in Europe.

The species of fish enumerated above represent the most important objects of attention and action of the Commission, although some work has been done in connection with the multiplication of the California trout, the brook trout, the striped bass, the Spanish mackerel, and the oyster. Full details in regard to all these points will be found in the report of the United States Fish Commission.

Before closing this subject brief reference may be made to an important improvement in the method of distributing the young fish on the part of the Commission. Heretofore this has been done by messengers in charge of a certain number of cans containing young fish, and traveling in baggage cars or express trains. Although the railroads have almost uniformly been extremely courteous and liberal in their co-operation with the Commission, allowing, without extra charge, the transportation of as many as from twelve to sixteen large cans of fish, yet that mode of distribution was found inadequate to the requirements, and the experiment was accordingly tried of fitting up a car as a refrigerator, in which a much larger supply of fish could be carried and kept at a uniform temperature sufficiently low to prevent injury to the fish by the summer's heat. Accordingly, by authority of Mr. Isaac Hinckley, president of the Philadelphia, Wilmington and Baltimore Railroad Company, one of the baggage cars of the company was altered to a refrigerator car of the Bidgway patent under the direction of the patentee. This has been tested and found to answer an admirable purpose by the delivery of the young fish at the most remote points practically without any loss.

#### FISHERIES CENSUS.

In my report for 1880 I presented in considerable detail an account of the arrangement made with General Francis A. Walker, Superintendent of the Census, by which the investigation of the fisheries of the United States was undertaken as the joint enterprise of the United States Fish Commission and Census Bureau. This investigation was to be made as complete as possible, statistically, historically, and with regard to the methods employed at the present time in the fishery industries. The preparation of a statistical and historical report upon the fish-

eries, to form one of the series to be presented by the Superintendent of the Census as the result of his investigations in 1880, has been the main object of the work; but in connection with this statistical work, extensive investigation into the methods of the fisheries, into the distribution of the fishing grounds, and the natural history of useful aquatic animals, has been, and is being, carried on. The direction of this investigation from the start has been confided to Mr. G. Brown Goode, who was appointed agent of the Census Office, and has been carrying on the work in addition to the performance of his duties in connection with the National Museum.

The work began on July 1, 1879, and the final report, it is hoped, will be ready for publication as early as February, 1882. The scheme of investigation and the methods of inquiry are described at length on pages 78, 79 of my report for 1880, and in this place it seems necessary only to mention under the head of each district the names of the persons employed and the dates during which the investigation was carried on. The districts and departments, twenty-four in number, have been covered as follows:

I. Coast of Maine east of Portland, by R. E. Earll and Capt. J. W. Collins, from August 1 to October, 1879, and from July 29 to October 20, 1880.

II. Portland to Plymouth (except Cape Ann) and eastern side of Buzzard's Bay, by W. A. Wilcox, from September 2, 1879, to March 1, 1881.

III. Cape Ann, by A. Howard Clark, from September, 1879, to November, 1880.

IV. Cape Cod, by F. W. True, from July, 1879, to October, 1879, and during September and October of 1880.

V. Provincetown, by Capt. N. E. Atwood, from August, 1879, to August, 1880.

VI. Rhode Island and Connecticut, west to the Connecticut River, by Ludwig Kumlien, from August 16 to October 16, 1880.

VII. Long Island and north shore of Long Island Sound and west to Sandy Hook, by Fred. Mather, from August 1, 1879, to July, 1881.

VIII. New York City, by Barnet Phillips, from January, 1880, to July, 1881.

IX. Coast of New Jersey, by R. E. Earll, during December, 1880.

X. Philadelphia, by C. W. Smiley and W. V. Cox, during November, 1880.

XI. Coast of Delaware, by Capt. J. W. Collins, during December, 1880.

XII. Baltimore and the oyster industry of Maryland, by R. H. Edmunds, at various intervals during 1880.

XIII. Atlantic coast of Southern States, by R. E. Earll, from January to July, 1880.

XIV. Gulf coast, by Silas Stearns, from August, 1879, to July, 1880.

XV. Coast of California, Oregon, and Washington Territory, by Prof. D. S. Jordan and C. H. Gilbert, from January, 1880, to January, 1881.

XVI. Puget Sound, by James G. Swan, from January, 1880, to January, 1881.

XVII. Alaska seal fisheries, by Dr. T. H. Bean, from June to October, 1880.

XVIII. Great Lakes fishery, by Ludwig Kumlien, from August, 1879, to August, 1880.

XIX. River fisheries of Maine, by C. G. Atkins, during 1880.

XX. The shad and alewife fisheries, by Col. Marshall McDonald, from October, 1879, to July, 1881.

XXI. Oyster fisheries, by Ernest Ingersoll, from September, 1879, to July, 1881.

XXII. Lobster and crab fisheries, by Richard Rathbun, from January, 1880, to July, 1881.

XXIII. Turtle and terrapin fisheries, by F. W. True, from October, 1880, to July, 1881.

XXIV. The seal, sea elephant, and whale fisheries, by A. Howard Clark, from November, 1880, to February, 1881.

Respectfully submitted.

SPENCER F. BAIRD,  
*Secretary of the Smithsonian Institution.*

## APPENDIX TO THE REPORT OF THE SECRETARY,

### CONTAINING

1. Report on the Operations of Exchanges for 1881. By GEORGE H. BOEHMER.
2. Report of the Assistant Director of the U. S. National Museum: G. BROWN GOODE.
3. Report of the Chemist: F. W. TAYLOR.

## APPENDIX TO THE REPORT OF THE SECRETARY.

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### REPORT ON THE OPERATIONS OF EXCHANGES.

BY GEORGE H. BOEHMER.

The increase in the number of "foreign correspondents" of the Institution since the publication of the last printed list, corrected to January, 1878, together with numerous changes in organizations, has rendered necessary the preparation of a new edition of the pamphlet list brought down to the end of the past year. This has involved the distribution of a circular of formal inquiries to each of our correspondents, and considerable labor in the compilation of the information obtained from the replies. The new "List of foreign correspondents," corrected to January, 1882, has been carefully transcribed, and is now in the hands of the printer. The original replies received have been arranged and bound in volumes, so as to be readily accessible for reference at any time.

In addition to this list, card catalogues have been prepared, showing at a glance, besides the name of each institution, the date of its establishment, and the total number of volumes in its library, how many of these are Smithsonian publications, and designating the number of volumes of the various series, and in this catalogue it is intended to enter the Smithsonian publications to be sent successively to the establishment.

Another card catalogue has been commenced, in which it is intended to show :

1. The date of receipt of packages for any society, designating the name of the sender and the contents of the parcels, if possible, and for this purpose it is earnestly requested that all packages to be forwarded through the Smithsonian Institution should have the name of the sender and the contents plainly marked on the wrapper.
2. The date of transmittal, giving the number of the respective invoice and of the box containing the parcel ; and
3. The date of acknowledgment by the consignee.

This will necessarily increase the labor of the working force, but it is hoped will promote the efficiency of the system also, and facilitate by this series of checks the tracing of any miscarried parcel.

The Smithsonian Institution, through its international exchange, is at present in correspondence with 2,908 societies, located as follows:

AFRICA.		ASIA.	
Algeria.....	9	China.....	8
Azores.....	1	India.....	39
Cape Colonies.....	6	Japan.....	8
Egypt.....	8	Java.....	7
Liberia.....	2	Philippine Islands.....	3
Madeira.....	1	Strait Settlements.....	3
Malta.....	1		
Mauritius.....	5		
Mozambique.....	1		
St. Helena.....	2		
	36		68
AMERICA.		AUSTRALASIA.	
British America:		New South Wales.....	15
Canada.....	23	Queensland.....	4
Manitoba.....	1	South Australia.....	8
New Brunswick.....	3	Tasmania.....	7
Newfoundland.....	1	New Zealand.....	27
Nova Scotia.....	5	Victoria.....	20
		West Australia.....	1
	33		82
Central America:		EUROPE.	
Costa Rica.....	1	Austria-Hungary.....	172
Guatemala.....	2	Belgium.....	115
		Bulgaria.....	1
	3	Denmark.....	32
Mexico:		France.....	489
Mexico.....	23	Germany.....	580
	23	England.....	369
West Indies:		Ireland.....	42
Bahamas.....	1	Scotland.....	47
Barbadoes.....	1	Wales.....	5
Cuba.....	8	Greece.....	11
Guadeloupe.....	1	Iceland.....	13
Jamaica.....	1	Italy.....	221
Trinidad.....	1	Netherlands.....	81
Turk's Island.....	1	Norway.....	33
	14	Portugal.....	39
South America:		Russia.....	172
Argentine Republic.....	17	Servia.....	1
Bolivia.....	1	Spain.....	29
Brazil.....	10	Sweden.....	28
British Guiana.....	3	Switzerland.....	83
Chili.....	12	Turkey.....	16
Columbia.....	3		2,578
Dutch Guiana.....	2	POLYNESIA.	
Ecuador.....	1	Sandwich Islands.....	2
Paraguay.....	1		2
Peru.....	4	MISCELLANEOUS.	
Uruguay.....	5	Miscellaneous.....	7
Venezuela.....	3		7
	62	Total.....	2,908
RECAPITULATION.			
Africa.....	36	Asia.....	68
America:		Australasia.....	82
British America.....	33	Europe.....	2,578
Central America.....	3	Polynesia.....	2
Mexico.....	23	Miscellaneous.....	7
West Indies.....	14		
South America.....	62	Total.....	2,908

*Comparative table of foreign institutions in correspondence with the Smithsonian Institution during the last ten years:*

1872.....	1,985	1877.....	2,330
1873.....	2,145	1878.....	2,333
1874.....	2,146	1879.....	2,481
1875.....	2,207	1880.....	2,602
1876.....	2,275	1881.....	2,908

In the Smithsonian system two distinct branches are represented, namely, the "Foreign Exchange" and the "Domestic Exchange," to which may be added the "Government Exchange."

## 1.—FOREIGN EXCHANGE.

The "Foreign Exchange" consists in the collecting, registering, and sending, in regular transmissions to agents appointed either by the various governments or paid by the Smithsonian Institution, of its own publications, those of the various government departments, scientific establishments and individuals of this country, while the "Domestic Exchange" represents donations made by corresponding establishments and individuals abroad in return for contributions from this country.

The Smithsonian Institution, in this system, offering to correspondents a safe and gratuitous channel of intercommunication, has to insist upon the strict adherence to certain rules adopted principally in view of the free admission, into all parts of the world, of boxes and packages bearing its official stamp.

These conditions being well known to the "Home Correspondents," the following circular is in course of preparation, and will be distributed to all correspondents abroad on occasion of the next transmission of the annual report, which will take place in the earlier part of the coming year.

*Rules adopted relative to scientific and literary exchanges.*

1. Transmissions through the Smithsonian Institution from foreign countries to be confined exclusively to books, pamphlets, charts, and other printed matter sent as donations or exchanges, and not to include those procured by purchase. The Institution and its agents will not receive for any address apparatus and instruments, philosophical, medical, etc., including microscopes, whether purchased or presented, nor specimens of natural history, except where especial permission from the Institution has been obtained.

2. A list of the addresses and a statement of contents of each sending to be mailed to the Smithsonian Institution at or before the time of transmission.

3. Packages to be legibly addressed and to be indorsed with the name of the sender and their contents.

4. Packages to be enveloped in stout paper, and securely pasted or tied with strong twine—never sealed with wax.

5. No package to a single address to exceed one-half of one cubic foot in bulk.

6. To have no inclosures of letters.

7. To be delivered to the Smithsonian Institution or its agents free of expense.

8. To contain a blank acknowledgment, to be signed and returned by the party addressed.

9. Should *returns* be desired, the fact is to be explicitly stated on or in the package.

10. Unless these conditions are complied with the parcels cannot be forwarded by the Institution.



*Centers of distribution.*

In order to facilitate the scientific and literary intercourse between the various countries, the bureaux, societies, and individuals enumerated in the following table have been authorized to accept exchanges for transmission to this country, and to distribute in their respective countries the sendings made through the Smithsonian Institution.

Country.	City.	Agency.
Argentine Republic.....	Buenos Aires.....	Museo Publico.
Austria-Hungary.....	.....	Same as Germany.
Bavaria.....	.....	Do.
Belgium.....	Brussels.....	Commission Belge d'Echange International.
Brazil.....	Rio Janeiro.....	Commissão Central Brasileira de Permutações Internacionais.
British America.....	.....	Same as Canada.
British Guiana.....	Georgetown.....	Observatory.
Canada.....	Montreal.....	McGill College.
Do.....	Ottawa.....	Geological Survey of Canada.
Cape Colonies.....	.....	Same as Great Britain.
Chili.....	Santiago.....	Universidad de Chili.
China.....	Shanghai.....	United States Consul-General.
Costa Rica.....	San José.....	Universidad.
Cuba.....	Havana.....	R. Universidad.
Denmark.....	Copenhagen.....	Kong. Danske Videnskabernes Selskab.
Dutch Guiana.....	Surinam.....	Koloniale Bibliotheek.
East Indies.....	.....	Same as Great Britain.
Ecuador.....	Quito.....	Observatorio.
Egypt.....	Cairo.....	Institut Egyptien.
Finland.....	.....	F. A. Brockhaus. Leipzig, Germany.
France.....	Paris.....	Commission Française des Echanges Internationaux. (Ministère de l'instruction publique et des beaux arts.)
Germany.....	Leipzig.....	Dr. Felix Flügel (49 Sidonien strasse).
Great Britain.....	London.....	William Wesley (28 Essex street, Strand).
Greece.....	Athens.....	Bibliothèque Nationale.
Guatemala.....	Guatemala.....	Sociedad Economica de amigos del Pais.
Haiti.....	Port-au-Prince.....	Secrétaire de l'Etat des Relations Extérieures.
Iceland.....	Reykjavik.....	Island Stúptibokasafn.
Italy.....	Rome.....	Biblioteca Nazionale Vittorio Emanuele.
Japan.....	Tokio.....	Minister of Foreign Affairs.
Liberia.....	Monrovia.....	Liberia College.
Mexico.....	Mexico.....	El Museo Nacional.
Netherlands.....	Harlem.....	Bureau Scientifique Central Néerlandais.
Netherlands India.....	.....	Same as Netherlands.
New Caledonia.....	.....	Same as Great Britain.
New South Wales.....	Sydney.....	Royal Society of New South Wales.
New Zealand.....	Wellington.....	Colonial Museum.
Norway.....	Christiania.....	Kong. Norske Frederiks Universitet.
Philippine Islands.....	Manila.....	Royal Economical Society.
Polynesia.....	Honolulu.....	Royal Hawaiian Agricultural Society.
Portugal.....	Lisbon.....	Escola Polytechnica.
Prussia.....	.....	Same as Germany.
Queensland.....	Brisbane.....	Government Meteorological Observatory.
Russia.....	St. Petersburg.....	Commission Russe des Echanges Internationaux. (Bibliothèque Impériale Publique.)
Saxony.....	.....	Same as Germany.
St. Helena.....	.....	Same as Great Britain.
South Australia.....	Adelaide.....	Astronomical Observatory.
Spain.....	Madrid.....	Real Academia de Ciencias.
Strait Settlements.....	.....	Same as Great Britain.
Sweden.....	Stockholm.....	Kong. Svenska Vetenskaps Akademien.
Switzerland.....	Berne.....	Eidgenossenschaft Bundeskanzlei.
Tasmania.....	Hobarton.....	Royal Society, Tasmania.
Trinidad.....	Port of Spain.....	Scientific Association.
Turk's Island.....	Grand Turk.....	Public Library.
United States of Colombia.....	Medellin.....	University of Antioquia.
Venezuela.....	Caracas.....	Dr. A. Ernst.
Victoria.....	Melbourne.....	Public Library.
Württemberg.....	.....	Same as Germany.

*Agents of transmission.*

In the shipment of Smithsonian exchanges the same liberality in granting free freights has been shown as in previous years, the following named transportation companies deserving especial acknowledgment:

Anchor Steamship Company, Compagnie Générale Transatlantique, Cunard Steamship Company, Hamburg-American Packet Company, Inman Steamship Company, Merchants' Line of Steamers, Netherlands-American Steam Navigation Company, New York and Brazil Steamship Company, New York and Mexico Steamship Company, North German Lloyd Steamship Company, Pacific Mail Steamship Company, Pacific Steam Navigation Company, Panama Railroad Company, Red Star Line, Steamship Lines for Brazil, Texas, Florida, and Nassau, N. P., White Cross Line of steamers of Antwerp.

The transmission of the Smithsonian exchanges has been effected through the following named parties.

Country.	Shipping agents.
Antigua .....	Thomas Dennison, New York.
Argentine Republic .....	Consul Carlos Carranza, New York.
Belgium .....	Red Star Line, Peter Wright and Sons, New York; White Cross Line, Funch, Edye & Co., New York.
Brazil .....	Charles Mackall, vice-consul, Baltimore.
Chile .....	Consul-General C. de Castro, New York.
Costa Rica .....	Pacific Mail Steamship Company, New York.
Cuba .....	Hipolito de Uriarte, consul-general for Spain, New York.
Denmark .....	Henrik Braem, consul-general, New York.
Ecuador .....	Francis Spies, consul, New York.
Egypt .....	S. L. Merchant & Co., New York.
France .....	Compagnie Générale Transatlantique, L. de Bébian, New York.
Germany .....	North German Lloyd, Oelrichs & Co., New York, and Schumacher & Co., Baltimore.
Great Britain .....	Cunard Steamship Company, Vernon Brown & Co., New York; North German Lloyd, Schumacher & Co., Baltimore.
Greece .....	Consul D. H. Botassi, New York.
Guatemala .....	Consul Jacob Baez, New York.
Haiti .....	Atlas Steamship Company, Pim, Forwood & Co., New York.
Italy .....	M. Raffa, consul-general, New York.
Japan .....	Consul-General Samro Takaki, New York.
Mexico .....	Consul-General Juan N. Navarro, New York.
Netherlands .....	Netherlands-American Steam Navigation Company, H. Cazeaux, New York.
New South Wales .....	R. W. Cameron & Co., New York.
New Zealand .....	R. W. Cameron & Co., New York.
Norway .....	Consul-General Christian Bors, New York.
Portugal .....	Consul-General Gustav Amsink, New York.
Queensland .....	North German Lloyd, Schumacher & Co., Baltimore; transfer made at Queensland department, London, England.
Russia .....	Hamburg-American Packet Company, Kunhardt & Co., New York; transfer made by consul-general of Russia, Hamburg.
South Australia .....	R. W. Cameron & Co., New York.
Spain .....	Consul-General Hipolito de Uriarte, New York.
Sweden .....	Consul-General Christian Bors, New York.
Switzerland .....	North German Lloyd, Schumacher & Co., Baltimore; transfer made by Consul-General von Heymann, in Bremen.
Turkey .....	Turkish Embassy, Washington, D. C.
Tasmania .....	North German Lloyd, Schumacher & Co., Baltimore; transfer made by Crown agents for the colonies, London, England.
Venezuela .....	Dallet, Boulton & Co., New York.
Victoria .....	R. W. Cameron & Co., New York.
West Indies .....	Pacific Mail Steamship Company, New York.

### 1. Receipt and distribution of exchanges.

At no time in the history of the Smithsonian Institution, even during the Centennial Exhibition of the United States, in Philadelphia, in 1876, and in the year following, has the increase in the receipt and distribution of the Smithsonian exchanges been so marked as in the past year. In 1877, when large presentations of documents were made in return for the many donations made by the various nations, through their representatives, and collections of books forwarded at the request of the respec-

tive commissioners, the increase over the year 1876 amounted to 25 per cent. The present year, however, presents results far superior to any on record, and these will be exhibited in the following tables:

I.—Receipts for foreign transmission.

	Number of pack- ages.	Weight.		Number of pack- ages.	Weight.
1.—FROM GOVERNMENT DE- PARTMENTS.					
		<i>Pounds.</i>			
Agricultural Department	325	1,789	Marietta (Ohio) College	6	34
Bureau of Military Justice	1	2	Museo Nacional, Mexico	108	78
Bureau of Statistics	3	47	Nederlandish Legation,		
Coast Survey	18	85	Washington	1	5
Commissary-General of Sub- sistence	1	1	Nova Scotian Society of Nat- ural Sciences, Halifax	17	32
Comptroller of Currency	900	645	Peabody Institute, Baltimore	1	5
Engineer Bureau	866	4,990	Pennsylvania Historical So- ciety, Philadelphia	53	41
Entomological Commission	1	4	Public School Library, Saint Louis	4	12
Fish Commission	8	70	Secretary of State, Lansing, Mich	1	41
Geological Survey (Rocky Mountain region)	54	270	Silk Association	140	231
Interior Department	173	768	State Library, Albany, N. Y.	1	10
National Museum	49	4,353		3,631	6,816
Naval Observatory	1,679	7,216	3.—FROM INDIVIDUALS.		
Ordinance Office	3	77	Abbe, Prof. C.	5	7
Quartermaster-General	4	25	Baird, Prof. S. F.	87	192
Revenue Marine	50	25	Bell, A.	3	14
Signal Office	120	2,206	Bessels, Emil	4	27
Surgeon-General's Office	8	95	Binney, W. G.	1	7
Surgeon-General (Marine Hospital)	53	25	Ellis, J. B.	1	2
Treasury Department	10	193	Enthoffer, Mr.	2	2
	4,326	22,903	Ferguson, Major F. B.	9	38
2.—FROM SCIENTIFIC SOCIETIES AND ESTABLISHMENTS.			Gill, Dr. T.	1	2
			Goode, Prof. G. Brown	3	82
Academy of Natural Sci- ences, Philadelphia	229	667	Gray, Dr. Asa	1	19
Academy of Sciences, New York	410	245	Greene, E. L.	1	2
Academy of Sciences, Saint Louis	1	10	Hall, Prof. James	150	1,154
American Association for the Advancement of Science	137	580	Harkness, Prof. William	11	7
American Entomological So- ciety, Philadelphia	17	32	Hawes, Dr. George W.	177	25
American Journal of Arts and Sciences, New Haven	192	72	Hayden, Dr. F. V.	2	26
American Journal of Mathe- matics, Baltimore	1	1	Hessel, Dr. Rudolph	2	5
American Pharmaceutical Association, Philadelphia	39	91	Holden, Prof. E. S.	1	8
American Philosophical So- ciety, Philadelphia	701	950	Hough, F. B.	3	18
Board of Public Charities, Philadelphia	26	55	Jackson, James	4	45
American Academy of Arts and Sciences, Boston	588	677	Jakerman & Carver	1	15
Boston Society of Natural History	312	1,869	King, Prof. C.	1	5
Brown Library, Providence, R. I.	2	31	Knight, Dr. E. H.	56	21
Buffalo (New York) Society of Natural Sciences	110	22	Lee, Dr. William	89	406
Canadian Journal	48	14	Lesquereux, Prof. Leo	1	21
Columbia College, New York	139	195	Mallery, Col. Garrick	1	4
Essex Institute, Salem, Mass	294	340	Mallet, J. Edmond	3	75
Geological Survey, Harris- burg, Penn.	29	457	Marnock, G. W.	1	15
Harvard College	1	9	Morong, Thomas	1	3
Johns Hopkins University, Baltimore	4	10	Nipher, F. E.	1	37
			Palmer, Joseph	2	4
			Phillips, Henry	3	10
			Rau, Dr. Charles	25	55
			Rhees, William J.	5	8
			Smith, Prof. J. H.	1	17
			Solberg, Mr.	1	3
			Stevenson, James	75	443
			Stockwell, J. N.	20	60
			Sullivan, George N.	5	13
			Thomas, Prof. C.	13	2
			Walker, S. T.	1	8
			Watson, Prof. Sereno	2	25
			Whitfield, R. P.	1	4
			Williams, N. R.	1	21
				768	2,937
			4.—Smithsonian Institution.	5,436	17,499
			Total	14,161	50,155

## II.—Receipts for domestic transmission.

	Number of boxes.	Number of parcels.	Weight.
			<i>Pounds.</i>
From Australia.....	2	32	50
Belgium.....	5	213	1,760
Brazil.....	4a	87	980
East Indies.....	1	14	106
France.....	14	1,027	3,243
Germany.....	34	2,542	8,178
Great Britain.....	23	1,369	6,808
For Library of Congress.....	15	—	2,855
Holland.....	2	87	340
Italy.....	2	58	410
Portugal.....	1	1	31
Norway.....	2	151	405
Russia.....	4	258	780
Smithsonian Institution.....	—	1,937	7,101
Switzerland.....	2	114	250
Total.....	111	7,890	33,291

## III.—Receipts for government exchanges.

From the Public Printer: 300 sets, of 50 copies each, of the public documents printed by order of Congress..... Copies, 15,000.

## RECAPITULATION.

	Number of parcels.	Weight.
		<i>Pounds.</i>
I. For foreign transmission:		
1. From government departments.....	4,326	22,908
2. From scientific societies.....	3,631	6,816
3. From individuals.....	768	2,937
4. From Smithsonian Institution.....	5,436	17,499
II. For domestic transmission.....	7,890	33,291
Total.....	22,051	83,446

*Transmission of exchanges.*

The transmission of exchanges is ordinarily in direct proportion to the receipts. The year 1880, however, made, in a measure, an exception to this general rule, owing partly to a reorganization of the department and partly to an unusual augmentation of the receipts during the latter portion of the year, thus requiring an extra effort during the year 1881 not to fall behind in the transmission. This end has been attained, and the result now presented is favorable in every respect. All former accumulations have been worked off, and by giving immediate attention to the constantly incoming material nothing has been allowed to accumulate, and thus the working force in this department is fully prepared to transmit promptly any exchanges immediately upon receipt.

The number of boxes transmitted during the year amounted to 407, and compare with the transmission of former years as follows :

	Number of boxes.	Bulk in cubic feet.	Weight in pounds.
1872.....	179	954	26,850
1873.....	196	1,476	44,236
1874.....	131	933	27,990
1875.....	208	1,503	45,400
1876.....	323	2,261	80,750
1877.....	397	2,779	99,250
1878.....	309	2,160	69,220
1879.....	311	2,177	69,975
1880.....	268	1,976	60,300
1881.....	407	2,800	100,750

The 407 boxes sent during the year 1881 were distributed as follows : \*

Country.	Smithsonian exchanges.	National Museum.	Fish Commission.	Government.	Total.
<b>AMERICA.</b>					
Argentine Republic.....	2	1	.....	4	7
Brazil.....	4	1	.....	2	7
Canada.....	6	.....	.....	4	10
Chile.....	5	.....	.....	2	8
Cuba.....	2	.....	.....	.....	2
Ecuador.....	3	.....	.....	.....	3
Guatemala.....	1	.....	.....	.....	1
Haiti.....	.....	.....	.....	.....	.....
Mexico.....	4	3	.....	2	9
Nicaragua.....	1	.....	.....	.....	1
Venezuela.....	1	.....	.....	2	3
Total.....	29	6	.....	12	53
<b>ASIA.</b>					
China.....	3	.....	.....	.....	3
East Indies. (Included in England.)	.....	.....	.....	.....	.....
Japan.....	2	2	.....	2	6
Java. (Included in Holland.)	.....	.....	.....	.....	.....
Total.....	5	2	.....	2	9
<b>AFRICA.</b>					
Algiers. (Included in France.)	.....	.....	.....	.....	.....
Cape Colonies. (Included in England.)	.....	.....	.....	.....	.....
<b>AUSTRALIA.</b>					
New South Wales.....	2	1	.....	2	5
New Zealand.....	.....	4	.....	2	6
Queensland.....	.....	1	.....	2	3
South Australia.....	.....	.....	.....	2	2
Tasmania.....	.....	.....	.....	2	2
Victoria.....	2	1	.....	2	5
Total.....	4	7	.....	12	23

\* In all cases the number of boxes given in this report includes the boxes sent under the system of Government documents exchanged to the various governments specified in the special report appended, and the transmissions to Canada which will be found specified in the detailed report on domestic exchanges.

Country.	Smithsonian exchanges.	National Museum.	Fish Com- mission.	Government.	Total.
<b>EUROPE.</b>					
Austria (Smithsonian Exchanges included in Germany)		2			2
Bavaria (Smithsonian Exchanges included in Germany)				2	2
Belgium	5	1		2	8
Denmark	2	2		2	6
France	29	2	1	4	36
Germany	63	3		2	70
Great Britain	48	4		2	54
Greece				2	2
Italy	28	3		15	46
Netherlands	10	2		2	14
Norway	3	4		2	9
Portugal	2	2		2	6
Prussia (Smithsonian Exchanges included in Germany)				2	2
Russia	20	2		15	37
Saxony (Smithsonian Exchanges included in Germany)				2	2
Spain	2			2	4
Sweden	6	2		2	10
Switzerland	6			2	8
Turkey				2	2
Wurtemberg (Smithsonian Exchanges included in Germany)				2	2
<b>Total</b>	<b>226</b>	<b>29</b>	<b>1</b>	<b>66</b>	<b>322</b>

## RECAPITULATION.

America	29	6		18	53
Asia	5	2		2	9
Australia	4	7		12	23
Europe	226	29	1	66	322
<b>Total</b>	<b>264</b>	<b>44</b>	<b>1</b>	<b>98</b>	<b>407</b>

## 2.—DOMESTIC EXCHANGES.

The receipt of exchanges for domestic transmission has been stated as being 7,890 packages. These, together with the accumulation from the year 1880, amounted to 8,433 packages, which have *all* been worked off, not one package remaining in the office at the expiration of the year.

The total number of packages transmitted compares with former years as follows :

	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.
Total addresses of institutions	300	463	462	329	316	392	292	444	385	600
Total addresses of individuals	287	226	288	281	328	374	370	341	560	454
Total number of parcels to institutions	3,694	3,876	3,221	3,619	3,705	3,868	4,059	5,786	4,021	7,086
Total number of parcels to individuals	941	906	1,105	1,042	1,148	1,094	1,233	1,185	1,506	1,347
<b>Total number of parcels</b>	<b>4,635</b>	<b>4,782</b>	<b>4,326</b>	<b>4,661</b>	<b>4,853</b>	<b>4,962</b>	<b>5,292</b>	<b>6,971</b>	<b>5,587</b>	<b>8,433</b>

And were distributed to societies into the various States and Territories of the United States and of British America as follows:

States and Territories.	Societies.	Parcels.	States and Territories.	Societies.	Parcels.
Alabama .....	1	1	Nebraska .....	2	2
Arkansas .....	5	9	New Hampshire .....	6	14
California .....	21	148	New Jersey .....	11	41
Colorado .....	2	2	New York .....	85	797
Connecticut .....	16	322	North Carolina .....	4	4
Delaware .....	1	1	Ohio .....	37	149
District of Columbia .....	46	2,379	Oregon .....	3	3
Georgia .....	6	10	Pennsylvania .....	17	747
Illinois .....	34	209	Rhode Island .....	9	21
Indiana .....	14	27	South Carolina .....	7	24
Iowa .....	15	135	Tennessee .....	8	8
Kansas .....	5	17	Texas .....	2	3
Kentucky .....	5	11	Utah .....	1	1
Louisiana .....	8	49	Vermont .....	7	49
Maine .....	15	53	Virginia .....	10	16
Maryland .....	15	84	Washington Territory .....	1	1
Massachusetts .....	72	1,039	West Virginia .....	3	3
Michigan .....	15	61	Wisconsin .....	11	157
Minnesota .....	7	28	British America .....	54	235
Mississippi .....	2	2			
Missouri .....	17	224	Total .....	600	7,086

*List of consignees.*

Recipients.	Packages.	Recipients.	Packages.
<b>ALABAMA.</b>		<b>CALIFORNIA—Continued.</b>	
Tuscaloosa :		Santa Clara :	
Geological Survey of Alabama .....	1	Santa Clara College .....	1
	1		148
<b>ARKANSAS.</b>		<b>COLORADO.</b>	
Fayetteville :		Denver :	
Industrial University .....	1	Governor Gilpin .....	1
Holly Grove :		State Library .....	1
Literary Institution .....	1		2
Judsonia :		<b>CONNECTICUT.</b>	
Judson University .....	1	Bridgeport :	
Little Rock :		Bridgeport Library and Reading Rooms .....	1
Governor of Arkansas .....	5	Hartford :	
Literary Institution .....	1	American Philological Society .....	1
	9	State Board of Agriculture .....	1
<b>CALIFORNIA.</b>		State Library .....	1
Berkeley :		Theological Institution of Connecticut .....	1
University of California .....	1	Trinity College .....	1
Marvaville :		Middletown :	
Marysville Library .....	1	Weesleyan Univer sity .....	3
Oakland :		New Britain :	
University of California .....	1	State Normal School .....	1
Sacramento :		New Haven :	
Free Library .....	1	American Journal of Science, etc .....	108
Society of Agriculture and Horticulture .....	1	American Oriental Society .....	38
State Library .....	3	Connecticut Academy of Science .....	139
San Francisco :		Sheffield Scientific School .....	6
Academy of Sciences .....	119	Yale College .....	19
Agricultural and Horticultural Society .....	2	Young Men's Institute .....	2
Bibliothèque de la Ligne .....	1	Waterbury :	
Corporation of the city .....	1	Bronson Library .....	1
Library .....	1		322
Lick Observatory .....	8	<b>DELAWARE.</b>	
Mechanics' Institute .....	1	Wilmington :	
Mercantile Library .....	2	Wilmington Institute .....	1
Odd Fellows' Library .....	1		1
Saint Ignatius College .....	1		
State Geological Survey .....	1		
State Horticultural Society .....	1		

## List of consignees—Continued.

Recipients.	Pack-ages.	Recipients.	Pack-ages.
<b>DISTRICT OF COLUMBIA.</b>		<b>ILLINOIS—Continued.</b>	
Washington:		Dearborn Observatory.....	6
Agricultural Department.....	129	Historical Society.....	1
American Medical Association.....	81	Illinois Staats Zeitung.....	1
Anthropological Society.....	3	Museum of Natural History.....	1
Army Medical Museum.....	6	Public Library.....	5
Belgian Legation.....	2	Theological Seminary.....	1
Board of Health.....	5	Evanston:	
Bureau of Education.....	34	Northwestern University.....	2
Bureau of Ethnology.....	3	Galesburg:	
Bureau of Medicine and Surgery.....	2	Knox College.....	1
Bureau of Navigation.....	9	Lombard University.....	1
Bureau of Statistics.....	28	Jacksonville:	
Census Office.....	17	Deaf and Dumb Institute.....	1
Coast Survey.....	68	Illinois College.....	1
Columbian University.....	3	Lebanon:	
Commissioners of District of Columbia.....	1	McKendree College.....	1
Commissioner of Indian Affairs.....	6	Monmouth:	
Engineer Bureau.....	15	Monmouth College.....	1
Entomological Commission.....	2	Warren County Library.....	1
General Land Office.....	3	Normal:	
Geological Survey.....	144	Museum of Natural History.....	6
Georgetown College.....	3	Ottawa:	
Georgetown Observatory.....	3	Ottawa Academy of Natural Sciences.....	1
Hydrographic Office.....	19	Peoria:	
Index Medicus.....	3	Mercantile Library.....	1
Interior Department.....	30	Rantoul:	
Library of Congress.....	106	Rantoul Literary Society.....	1
Light-house Board.....	1	Rock Island:	
Minister of China.....	14	Public Library.....	1
Mint Bureau.....	7	Springfield:	
National Academy of Sciences.....	175	Geological Survey of Illinois.....	4
National Museum.....	30	Library Association.....	1
Nautical Almanac.....	19	St. Joseph's College.....	1
Naval Observatory.....	113	State Library.....	1
Navy Department.....	10	Westfield:	
Ordinance Bureau.....	7	Westfield College.....	1
Patent Office.....	70	Wheaton:	
Philosophical Society.....	27	Wheaton College.....	1
Provost Marshal General.....	2		209
Signal Office.....	56		
Smithsonian Institution.....	822		
State Department.....	35		
Surgeon-General.....	297		
Surgeon-General, Marine Hospitals.....	10		
Treasury Department.....	12		
War Department.....	29		
	2, 379		
<b>GEORGIA.</b>		<b>INDIANA.</b>	
Athens:		Bloomington:	
University of Georgia.....	1	University of Indiana.....	1
Atlanta:		Crawfordsville:	
Agricultural Department and State Agri- cultural Society.....	1	Wabash College.....	1
City Library.....	1	Fort Wayne:	
Cave Spring:		Concordia College.....	2
Institute for the Deaf and Dumb.....	1	Greencastle:	
Macon:		Asbury University.....	1
Public Library and Historical Society.....	1	Hanover:	
Savannah:		Hanover College.....	1
Historical Society.....	5	Indianapolis:	
	10	Academy of Science.....	2
		Geological Survey of Indiana.....	11
		Public Library.....	2
		State Library.....	1
		Meron:	
		Union Christian College.....	1
		New Albany:	
		Society of Natural History.....	1
		Notre Dame:	
		University of Notre Dame.....	1
		St. Meinard:	
		St. Meinard College.....	1
		Terra Haute:	
		State Normal School.....	1
			27
<b>ILLINOIS.</b>		<b>IOWA.</b>	
Abingdon:		Ames:	
Abingdon College.....	1	Iowa Agricultural College.....	1
Bloomington:		Davenport:	
Bloomington Library.....	1	Academy of Sciences.....	82
Weesleyan University.....	1	Griswold College.....	1
Carbondale:		Dee Moines:	
Southern Illinois Normal University.....	1	Governor of Iowa.....	4
Champaign:		State Library.....	2
Industrial University.....	1		
Chicago:			
Academy of Sciences.....	157		
Astronomical Observatory.....	8		





## List of consignees—Continued.

Recipients.	Pack- ages.	Recipients.	Pack- ages.
MASSACHUSETTS—Continued.		MICHIGAN—Continued.	
College Hill:		Lansing:	
Tuft's College .....	1	Agricultural College .....	1
Concord:		State Board of Health .....	17
Public Library .....	1	State Library .....	1
Gloucester:		Marquette:	
Sawyer Free Library .....	2	Geological Survey .....	1
Haverhill:		Olivet:	
Public Library .....	1	Olivet College .....	1
Hingham:		Port Huron:	
Public Library .....	1	Ladies' Library Association .....	1
Jamaica Plains:			61
Bussey Institute .....	22	MINNESOTA.	
Lancaster:		Duluth:	
Lancaster Town Library .....	1	Free Public Library .....	1
Lawrence:		Minneapolis:	
Public Library .....	1	Academy of Natural Sciences .....	12
Leicester:		Geological Survey .....	3
Public Free Library .....	1	University of Minnesota .....	2
Lowell:		Saint Paul:	
Mechanic Association .....	1	Chamber of Commerce .....	1
Lynn:		Historical Society .....	8
Public Library .....	1	Library Association .....	1
Nantucket:			28
Athenaeum .....	1	MISSISSIPPI.	
Newburyport:		Daleville:	
Public Library .....	1	Cooper Institute .....	1
Newton Centre:		Oxford:	
Theological Institute .....	1	University of Mississippi .....	1
Northampton:			2
Public Library .....	1	MISSOURI.	
Quincy:		Fayette:	
Public Library .....	1	Central College .....	1
Salem:		Glasgow:	
American Association for the Advance- ment of Science .....	73	Observatory .....	2
Athenaeum .....	1	Jefferson City:	
Essex Institute .....	68	Governor of the State .....	1
Peabody Academy .....	121	State Board of Agriculture .....	3
South Hadley:		Liberty:	
Mount Holyoke Female Seminary .....	1	William Jewell College Library .....	4
Springfield:		Rolla:	
City Library .....	1	Geological Survey of Missouri .....	7
Taunton:		Saint Louis:	
Public Library .....	1	Academy of Sciences .....	183
Watertown:		Botanical Garden .....	1
Free Public Library .....	1	Corporation of the city .....	1
Wellesley:		Mercantile Library .....	2
Wellesley College .....	1	Missouri Historical Society .....	3
Williamstown:		Peabody Academy .....	1
Williams College .....	1	Public School Library .....	9
Woburn:		Saint Louis University .....	1
Public Library .....	1	Washington University .....	3
Worcester:		Westliche Post .....	1
American Antiquarian Society .....	20	Warrensburg:	
Free Institute of Industry .....	1	State Normal School .....	1
Public Library .....	1		224
Society of Natural History .....	1	NEBRASKA.	
	1,039	Lincoln:	
MICHIGAN.		State Library .....	1
Adrian:		Peru:	
Adrian College .....	1	State Normal School .....	1
Ann Arbor:			2
Geological Survey of Michigan .....	2	NEW HAMPSHIRE.	
Observatory .....	14	Concord:	
University of Michigan .....	5	Historical Society .....	3
Coldwater:		State Library .....	1
Michigan Library Association .....	9	Hanover:	
Detroit:		Dartmouth College .....	7
Public Library .....	1	Dartmouth College Observatory .....	1
State Agricultural Society .....	5		
Hillsdale:			
Hillsdale College .....	1		
Kalamazoo:			
Kalamazoo College .....			

## List of consignees—Continued.

Recipients.	Pack-ages.	Recipients.	Pack-ages.
<b>NEW HAMPSHIRE—Continued.</b>		<b>NEW YORK—Continued.</b>	
Manchester:		Hornellsville:	
City Library.....	1	Library Association.....	1
Portsmouth:		Ithaca:	
Athenæum.....	1	Cornell University.....	8
	14	New York City:	
		American and Foreign Bible Society.....	1
<b>NEW JERSEY.</b>		American Chemical Society.....	9
Hoboken:		American Ethnological Society.....	6
Stevens Institute of Technology.....	13	American Geographical Society.....	132
Newark:		American Institute.....	16
Historical Society.....	1	American Medical Journal.....	17
New Brunswick:		American Museum of Natural History.....	16
Geological Survey of New Jersey.....	2	Astor Library.....	29
Rutgers College.....	1	College of the city.....	1
Newton:		College of Pharmacy.....	1
Newton Library Association.....	1	Columbia College.....	2
Princeton:		Cooper Union.....	1
College of New Jersey.....	13	Druggists' Circular.....	1
Green's School of Science.....	1	Engineering and Mining Journal.....	3
Observatory.....	0	Genealogical Society.....	2
Theological Seminary.....	1	Historical Society.....	4
Rahway:		Journal of Chemistry.....	1
Library Association.....	1	Lenox Library.....	1
Trenton:		Medical Library and Journal Association.....	1
State Library.....	1	Medical Recorder.....	1
	41	Mercantile Library.....	3
<b>NEW YORK.</b>		Military Service Institute.....	1
Albany:		Natural History Society.....	1
Adirondack Survey.....	4	New York Academy of Medicine.....	2
Albany Institute.....	15	New York Academy of Sciences.....	153
Commissioners State Park.....	2	New York Belletristisches Journal.....	1
Dudley Observatory.....	32	New York Society Library.....	2
New York Medical Society.....	2	New York Times.....	9
Secretary of State.....	2	New York Tribune.....	1
State Agricultural Society.....	27	Observatory.....	15
State Cabinet.....	22	School of Mines.....	15
State Library.....	76	Scientific American.....	1
State Normal School.....	1	Union Theological Seminary.....	2
Regents State Universities.....	14	University of the city.....	2
Alfred Centre:		United States Sanitary Commission.....	5
Alfred University.....	1	Poughkeepsie:	
Annandale:		Society of Natural Sciences.....	9
St. Stephen's College.....	1	Vassar College.....	4
Auburn:		Rochester:	
Agricultural and Mechanics' College.....	1	University.....	1
Bath:		Schenectady:	
Library Association.....	1	Union College.....	3
Brooklyn:		Syracuse:	
Baker Collegiate Institute.....	1	Central Library.....	1
Brooklyn Library.....	2	University.....	1
Entomological Society.....	1	Troy:	
Long Island Historical Society.....	2	Female Seminary.....	1
Buffalo:		Rensselaer Polytechnic Institute.....	1
Buffalo Practical School.....	3	Young Men's Association.....	1
Buffalo Society of Natural Sciences.....	75	West Point:	
Grosvener Free Library.....	1	United States Military Academy.....	6
North American Entomologist.....	1		797
Young Men's Library.....	1	<b>NORTH CAROLINA.</b>	
Canton:		Lenoir:	
Saint Lawrence University.....	1	Davenport Female College.....	1
Clinton:		Raleigh:	
Hamilton College.....	1	State Library.....	1
Litchfield Observatory.....	6	Trinity:	
Corning:		Trinity College.....	1
Corning Library.....	1	Warrenton:	
Elmira:		Female Collegiate Institute.....	1
Young Men's Christian Association.....	1		4
Fordham:		<b>OHIO.</b>	
St. John's College.....	1	Ashtabula:	
Geneva:		Anthropological Society.....	2
Hobart College.....	1	Athens:	
Hamilton:		Ohio University.....	1
Madison University.....	1		

## List of consignees—Continued.

Recipients.	Pack-ages.	Recipients.	Pack-ages.
OHIO—Continued.		PENNSYLVANIA—Continued.	
Cincinnati:		Gettysburg:	
Cincinnati University.....	2	Pennsylvania College.....	1
Cincinnati Volksblatt.....	1	Theological Seminary.....	1
Cincinnati Volkszeitung.....	1	Harrisburg:	
Mercantile Library.....	2	Geological Survey.....	6
Mussey Medical Library.....	1	State Library.....	3
Observatory.....	30	Haverford:	
Public Library.....	6	Haverford College.....	1
Society of Natural History.....	17	Lewisburg:	
Cleveland:		University of Lewisburg.....	1
Case Library.....	1	Mansfield:	
Kirtland Society of Natural Sciences.....	1	State Normal School.....	1
Public School Library.....	1	Meadville:	
Columbus:		Theological Seminary.....	1
Geological Survey of Ohio.....	3	Media:	
State Board of Agriculture.....	41	Delaware County Institute of Science.....	1
State Horticultural Society.....	13	New Wilmington:	
State Library.....	4	Westminster College.....	1
State University.....	1	Philadelphia:	
Dayton:		Academy of Natural Sciences.....	299
Public Library.....	1	American Entomological Society.....	46
Delaware:		American Journal of Conchology.....	5
Weeleyan University.....	1	American Naturalist.....	13
Fremont:		American Pharmaceutical Association.....	14
Burchard Library.....	1	American Philosophical Society.....	195
Gambier:		Apprentices' Library.....	1
Kenyon College.....	1	Athenæum.....	1
Granville:		Board of Public Education.....	4
Denison University.....	1	Board of Public Health.....	1
Hiram:		Board of Trade.....	3
Hiram College.....	1	Central High School.....	4
Hudson:		College of Pharmacy.....	1
Western Reserve College.....	1	Corporation of the City.....	1
Lebanon:		Evening Bulletin.....	1
Mechanics' Institute.....	1	Franklin Institute.....	44
Marietta:		Geological Survey.....	2
Marietta College.....	1	German Society.....	1
Oberlin:		Historical Society of Pennsylvania.....	9
Oberlin College.....	1	Library Association of Friends.....	2
Painesville:		Library Company.....	4
Lake Erie Female Seminary.....	1	Magnetic and Meteorological Observatory	
Springfield:		of Girard College.....	5
Public Library.....	1	Medical Times.....	15
Tiffin:		Mercantile Library Company.....	2
Heidelberg College.....	1	Naturalists' Leisure Hour.....	1
Toledo:		Numismatic and Archaeological Society.....	1
Public Library.....	1	Philadelphia Hospital.....	2
Urbana:		Presbyterian Board of Publication.....	1
Central Ohio Scientific Association.....	3	University of Pennsylvania.....	2
Urbana University.....	1	Wagner Free Institute.....	11
Westerville:		Zoological Society.....	20
Otterbein University.....	1	Pittsburg:	
Wooster:		Mercantile Library.....	1
Wooster University.....	1	Strathmore:	
Yellow Springs:		Strathmore College.....	1
Antioch College.....	1	South Bethlehem:	
	149	Lehigh University.....	1
		West Grove:	
		East Pennsylvania Experimental Farm.....	1
OREGON.			747
Forest Grove:		RHODE ISLAND.	
Pacific University.....	1	Newport:	
Portland:		Redwood Library.....	1
Library Association.....	1	Providence:	
Salem:		Athenæum.....	2
State Library.....	1	Brown University.....	10
	3	Historical Society.....	3
PENNSYLVANIA.		Normal School.....	1
Allegheny:		Public Library.....	1
Observatory.....	11	Register of Births, etc.....	1
Easton:		Woonsocket:	
Institute of Mining Engineers.....	8	Harris Institute Library.....	1
Lafayette College.....	4		21

## REPORT ON THE OPERATIONS OF EXCHANGES.

*List of consignees—Continued.*

Recipients.	Pack-ages.	Recipients.	Pack-ages.
SOUTH CAROLINA.		WASHINGTON TERRITORY.	
Charleston:		Seattle:	
Elliot Society .....	14	Territorial University .....	1
Library Society .....	3		
State Medical College .....	2		1
Columbia:			
State Library .....	2		
State University .....	1		
Due West:		WEST VIRGINIA:	
Erskine College .....	1	Flemington:	
Greenwich:		West Virginia College .....	1
Furman University .....	1	Shepherdstown:	
	24	Shepherd College .....	1
		Wheeling:	
		Natural History Society .....	1
			3
TENNESSEE.		WISCONSIN:	
Columbia:		Appleton:	
Athenaeum .....	1	Lawrence University .....	1
Hiawasee:		Beloit:	
Hiawasee College .....	1	Geological Survey of Wisconsin .....	6
Jackson:		Janesville:	
Southern Baptist University .....	1	Wisconsin Institute for Educating the	
Maryville:		Blind .....	1
Maryville College .....	1	Madison:	
Memphis:		Historical Society of Wisconsin .....	8
Christian Brothers' College .....	1	State Agricultural Society of Wisconsin .....	40
Nashville:		Washburn Observatory .....	11
School for the Blind .....	1	Wisconsin Academy of Sciences .....	52
University of Nashville .....	1		
Vanderbilt University .....	1	Madison:	
	8	Historical Society of Wisconsin .....	8
		State Agricultural Society of Wisconsin .....	40
TEXAS.		Washburn Observatory .....	11
Austin:		Wisconsin Academy of Sciences .....	52
Public Library .....	1		
Chapel Hill:		Madison:	
Soulé University .....	2	Historical Society of Wisconsin .....	8
	3	State Agricultural Society of Wisconsin .....	40
		Washburn Observatory .....	11
UTAH.		Wisconsin Academy of Sciences .....	52
Salt Lake City:			
University of Deseret .....	1	Madison:	
	1	Historical Society of Wisconsin .....	8
		State Agricultural Society of Wisconsin .....	40
VERMONT.		Washburn Observatory .....	11
Castleton:		Wisconsin Academy of Sciences .....	52
Orleans County Society of Natural Sciences .....	40		
Burlington:		Madison:	
Fletcher Free Public Library .....	1	Historical Society of Wisconsin .....	8
University of Vermont .....	1	State Agricultural Society of Wisconsin .....	40
Derby:		Washburn Observatory .....	11
Society of Natural Sciences .....	1	Wisconsin Academy of Sciences .....	52
Montpelier:			
Historical Society of Vermont .....	1	Madison:	
State Library .....	4	Historical Society of Wisconsin .....	8
Saint Johnsbury:		State Agricultural Society of Wisconsin .....	40
Athenaeum .....	1	Washburn Observatory .....	11
	49	Wisconsin Academy of Sciences .....	52
VIRGINIA.		BRITISH AMERICA.	
Blacksburg:		Chicoutini, Canada:	
Agricultural and Mechanical College .....	1	Canadian Naturalist .....	1
Charlottesville:		Coburg, Canada:	
University of Virginia .....	5	Victoria University .....	1
Lexington:		Guelph, Canada:	
Virginia Military Institute .....	1	Ontario School of Agriculture .....	1
Washington and Lee University .....	1	Halifax, Nova Scotia:	
New Market:		Dalhousie College .....	1
Polytechnic Institute .....	1	Department of Mines .....	2
Richmond:		Legislative Library .....	1
Medical Society .....	1	Nova Scotia Institute of Natural Sciences .....	18
Richmond College .....	1	Hamilton, Canada:	
State Library .....	3	Scientific Association .....	5
Virginia Historical Society .....	1	Kingston, Canada:	
Salem:		Botanical Society of Canada .....	2
Roanoke College .....	1	Queen's College .....	1
	16	Montreal, Canada:	
		Canadian Medical and Surgical Journal .....	1
		Canadian Medical Record .....	1
		Department of Public Instruction .....	2
		Geological Survey of Canada .....	13
		Historical Society .....	1
		L'Union Medical de Canada .....	1
		McGill College .....	5
		Medical Association of Canada .....	1
		Natural History Society .....	1
		Société d'Agriculture .....	2
		Société d'Histoire Naturelle .....	36
		Ottawa, Canada:	
		Academy of Natural Sciences .....	4
		Department of Agriculture .....	1
		Geological Survey of Canada .....	5
		Legislative Library .....	1

*List of consignees.—Continued.*

Recipients.	Pack- ages.	Recipients.	Pack- ages.
BRITISH AMERICA—Continued.		BRITISH AMERICA—Continued.	
Quebec, Canada:		Library of the House of the Assembly...	1
Geographical Society.....	2	Literary and Historical Society.....	1
Historical and Natural History Society..	4	Magnetic Observatory.....	1
Laval University.....	2	Meteorological Office.....	7
Le Naturalist Canadien.....	2	Military Institute.....	1
Literary and Historical Society.....	15	Public Library.....	5
Literary and Philosophical Society.....	1	School of Practical Science.....	1
Parliamentary Library.....	2	Toronto Globe.....	1
Royal Academy of Sciences.....	1	Trinity College.....	1
Fredericton, New Brunswick:		University.....	1
University of New Brunswick.....	4	University College Library.....	7
St. Johns, New Brunswick:		Windsor, Nova Scotia:	
Legislative Library.....	6	University of King's College.....	1
St. Johns, Newfoundland:		Winnipeg, Manitoba:	
Geological Survey of Newfoundland.....	1	St. John's College.....	1
Toronto, Canada		Wolfville, Nova Scotia:	
Canadian Institute.....	41	Acadia College.....	1
Canadian Journal of Medicine.....	1		
Educational Department.....	1		235
Entomological Society.....	4		

*General recapitulation.*

## RECEIPTS.

	Boxes.	Parcels.	Books.
I. For foreign transmission.....		14, 161	
II. For domestic transmission.....	111	7, 890	
III. For government exchanges.....			15, 550
Total .....	111	22, 051	15, 550

## TRANSMISSIONS.

I. To establishments abroad.....	309	8, 433	
II. To home institutions and individuals.....	98		15, 550
III. To foreign governments.....			
Total .....	407	8, 433	15, 550

## 3.—EXCHANGE OF GOVERNMENT DOCUMENTS.

In 1868 Congress passed a resolution establishing a system of government exchanges under the charge of the Librarian of Congress, who invited the co-operation of the Smithsonian Institution by placing the management of this system in the hands of the Secretary.

A large quantity of public documents having accumulated at the Institution, it became necessary, in October, 1874, to address a circular to a number of governments, explaining the object of such a system of exchanges and inviting their co-operation.

The governments to whom this proposition was made were those of: Argentine Republic, Austria-Hungary, Belgium, Brazil, Chili, Denmark, France, German Empire, Great Britain, Guatemala, Hawaii, Italy, Hayti, Japan, Mexico, Netherlands, Peru, Portugal, Russia, Salvador, Spain, Sweden and Norway, Turkey, United States of Colombia, and Venezuela.

In accordance with the instructions received by the Institution in response, the following distribution of documents was made in 1875 :

	Cases.		Cases.
Turkey .....	6	Argentine Republic.....	6
France .....	6	Belgium.....	6
Portugal .....	6	Chile.....	6
Sweden .....	6	Mexico.....	6
Brazil .....	6		

These governments have successively been supplied with the continuations, and at present, full sets of fifteen boxes have been delivered to the following named governments or their official agents, as specified in the following table :

*Governments in exchange with the United States Government.*

Governments.	Establishments designated for the reception of government exchanges.
Argentine Confederation..	Minister of Foreign Affairs, Buenos Aires.
Bavaria.....	Königliche Bibliothek, Munich.
Belgium.....	Bibliothèque Royal, Brussels.
Brazil.....	Government, Rio Janeiro.
Buenos Aires.....	Government of Buenos Aires.
Canada.....	Parliamentary Library, Ottawa.
Do.....	Legislative Library, Toronto.
Chili.....	Museo Nacional, Santiago.
Denmark.....	Koninklike Bibliothek, Copenhagen.
France.....	Government and departments, Paris.
Germany.....	Reichstag Bibliothek, Berlin.
Great Britain.....	British Museum, London.
Greece.....	Bibliothèque Nationale, Athens.
Haiti.....	Sécrétaire d'Etat des Relations Extérieures, Port-au-Prince.
Italy.....	Bibliothèque Nazionale Vittorio Emanuele, Rome.
Japan.....	Minister of Foreign Affairs, Tokio.
Mexico.....	Government, Mexico.
Netherlands.....	Library of the States General, The Hague.
New South Wales.....	Parliamentary Library, Sydney.
New Zealand.....	Parliamentary Library, Wellington.
Norway.....	Foreign Office, Christiania.
Portugal.....	Government, Lisbon.
Prussia.....	Königliche Bibliothek, Berlin.
Queensland.....	Government, Brisbane.
Russia.....	Government, St. Petersburg.
Saxony.....	Königliche Bibliothek, Dresden.
South Australia.....	Government, Adelaide.
Spain.....	Government, Madrid.
Sweden.....	Government, Stockholm.
Switzerland.....	Government, Berne.
Tasmania.....	Parliamentary Library, Hobarton.
Turkey.....	Government, Constantinople.
Venezuela.....	University Library, Caracas.
Victoria.....	Public Library, Melbourne.
Württemberg.....	Königliche Bibliothek, Stuttgart.

*Shipping agents of government exchange.*

Country.	Agent.
Argentine Confederation..	Carlos Carranza, consul general, New York.
Bavaria.....	North German Lloyd, A. Schumacher & Co., Baltimore.
Belgium.....	White Cross Line, Funch, Edye & Co., and Red Star Line, P. Wright & Sons, New York.
Brazil.....	Charles Mackall, vice-consul, Baltimore.
Buenos Aires.....	Carlos Carranza, consul-general New York.
Canada:	
Ottawa.....	Baltimore and Ohio Express Company.
Toronto.....	Baltimore and Ohio Express Company.
Chili.....	C. DeCastro, consul-general, New York.
Denmark.....	Henrick Braem, consul-general, New York.
France.....	Compagnie Générale Transatlantique, L. de Bébian, New York.
Germany.....	North German Lloyd, A. Schumacher & Co., Baltimore.
Great Britain.....	North German Lloyd, A. Schumacher & Co., Baltimore.
Greece.....	D. W. Botassl, consul-general, New York.
Haiti.....	Atlas Steamship Company, Pim, Forwood & Co., New York.
Italy.....	M. Raffo, consul-general, New York.
Japan.....	Samro Takaki, consul-general, New York.
Mexico.....	Juan N. Navarro, consul-general, New York.
Netherlands.....	R. C. Burlage, consul-general, New York.
New South Wales.....	R. W. Cameron & Co., New York.
New Zealand.....	R. W. Cameron & Co., New York.
Norway.....	Christian Bors, consul-general, New York.
Portugal.....	Gustav Amsink, consul-general, New York.
Prussia.....	North German Lloyd, A. Schumacher & Co., Baltimore.
Queensland.....	North German Lloyd, A. Schumacher & Co., Baltimore.
Russia.....	Hamburg-American Packet Company, Kunhardt & Co., New York.
Saxony.....	North German Lloyd, A. Schumacher & Co., Baltimore.
South Australia.....	R. W. Cameron & Co., New York.
Spain.....	Hipolito de Uriarte, consul-general, New York.
Sweden.....	Christian Bors, consul-general, New York.
Switzerland.....	North German Lloyd, A. Schumacher & Co., Baltimore.
Tasmania.....	North German Lloyd, A. Schumacher & Co., Baltimore.
Turkey.....	Turkish Legation, Washington, D. C.
Venezuela.....	G. de Garmendia, consul-general, New York.
Victoria.....	R. W. Cameron & Co., New York.
Württemberg.....	North German Lloyd, A. Schumacher & Co., Baltimore.



LIST OF GOVERNMENT DOCUMENTS AND OTHER OFFICIAL PUBLICATIONS DISTRIBUTED BY THE SMITHSONIAN INSTITUTION TO FOREIGN GOVERNMENTS DURING THE YEAR 1881.

*Agricultural Department.*

Apportionment under the Tenth Census. 8vo. Paper.  
Special reports for 1880, Nos. 24-27, 29, 30. 8vo. Paper.  
Special reports for 1881, Nos. 31-33, 35-39. 8vo. Paper.

*Board of Health.*

Bulletin, vol. 2. Nos. 1-52 and index. 4vo. Paper.  
Supplements, Nos. 5-14. 4vo. Paper.  
Bulletin, vol. 3. Nos. 1-15. 4vo. Paper.

*Centennial exhibition.*

Report of the commission, 9 vols. 8vo. Cloth.

*United States Congress.*

Executive documents :

Third session Forty-fifth Congress. 8vo. Sheep.  
First session Forty-sixth Congress. Nos. 1-11. 8vo. Sheep.  
Second session Forty-sixth Congress, vols. 3, 9, 16, 17, 23, 25, 26.  
8vo. Sheep.

Congressional Record :

Second session Forty-sixth Congress, vol. 10 and index. 4vo. Half Russia.

Third session Forty-sixth Congress. 4vo. Half Russia.

Congressional Directory :

Third session Forty-sixth Congress, first and second editions. 8vo. Paper.

First session Forty-seventh Congress. 8vo. Paper.

Memorial addresses :

Zachariah Chandler. 8vo. Cloth.  
Beverly B. Douglass. 8vo. Cloth.  
Julian Hartridge. 8vo. Cloth.  
Gustave Schleicher. 8vo. Cloth.  
Alpheus S. Williams. 8vo. Cloth.  
Alfred M. Lay. 8vo. Cloth.  
Rush Clark. 8vo. Cloth.

**House of Representatives :**

Constitutional Manual, second session Forty-sixth Congress. 8vo.  
Half Russia.

House documents, third session Forty-fifth Congress, vol. x. 8vo.  
Sheep.

**House miscellaneous :**

Third session Forty-fifth Congress, vol. 3. 8vo. Sheep.

First session Forty-sixth Congress, vols. 2-5. 8vo. Sheep.

Second session Forty-sixth Congress, vols. 1, 2, 3, 5. 8vo. Sheep.

House journals, second session Forty-sixth Congress. 8vo. Sheep.

**House reports :**

Third session Forty-fifth Congress, vol. 1. 8vo. Sheep.

Second session Forty-sixth Congress, vol. 6. 8vo. Sheep.

**United States Senate :**

A compilation of questions of order and decisions thereon. 8vo.  
Paper.

Constitution of the United States with the amendments thereto.  
8vo. Paper.

**Senate documents :**

Third session Forty-fifth Congress, vol. 4. 8vo. Sheep.

First session Forty-sixth Congress, No. 37. 8vo. Sheep.

Second session Forty-sixth Congress, vols. 2, 4. 8vo. Sheep.

**Senate journal :**

Second session Forty-sixth Congress. 8vo. Sheep.

Third session Forty-sixth Congress. 8vo. Sheep.

**Senate miscellaneous :**

Second session Forty-fifth Congress. 8vo. Sheep.

Third session Forty-fifth Congress. 8vo. Sheep.

**Senate reports :**

Third session Forty-fifth Congress. 8vo. Sheep.

First and second sessions Forty-sixth Congress. 8vo. Sheep.

*Court of Claims.*

Cases decided in the Court of Claims at the December term, 1879, vol.  
15. 8vo. Paper.

*Department of the Interior.*

Catalogue of the library of the Interior Department. 4to. Paper.

Register of the department, August, 1880. 8vo. Paper.

Supplement to the catalogue of the library, November 8, 1879. 8vo.  
Paper.

**Bureau of Education :**

Circulars of information. 8vo. Paper :

Instruction in chemistry and physics.

The spelling reform.

**Bureau of Education—Continued.**

Relation of education to industry.  
Proceedings National Education Association.  
Education and crime.  
Library aids.  
The discipline of the school.  
Education in China and Siam.  
Educational tours in France.  
Industrial education in Europe.

**General Land Office :**

Survey of public lands and private land claims. 8vo. Paper.  
Instructions to Surveyors General. 8vo. Paper.  
Circulars :

“How to obtain title to public lands.” 8vo. Paper.  
“Deposits on account of surveys.” 8vo. Paper.  
Rules of practice, approved December 20, 1880. 8vo. Paper.

**Board of Indian Commissioners :**

Twelfth annual report for the year 1880. 8vo. Paper.

**Office of Indian Affairs :**

Instruction to Indian agents, revised October 1, 1880. 8vo. Paper.

**United States Geological Survey of the Territories :**

Bulletin, vol. vi, Nos. 1 and 2. 8vo. Paper.  
Bulletin, vol. v, No. 4. 8vo. Paper.  
Miscellaneous publication, No. 12, North American Pinnipeds. 8vo. Paper.

**United States Entomological Commission :**

Bulletin No. 6. 8vo. Paper.  
Second report on the Rocky Mountain locust. 8vo. Paper.

**United States Patent Office :**

Decisions of the Commissioner for 1879. 8vo. Paper.  
Decisions of the Commissioner for 1880. 8vo. Paper.  
Statutes and rules relating to the registration of trade-marks and labels. 8vo. Paper.  
Patent laws, February, 1881, 8vo. Paper.  
Rules of practice, revised September 1, 1880. 8vo. Paper.

**United States National Museum :**

Proceedings of the National Museum, vol. 3. 8vo. Paper.  
Bulletins Nos. 17 and 21. 8vo. Paper.

**United States Pension Office:**

General Instructions to Special Examiners. 8vo. Paper.

**United States Surveys of the Rocky Mountain Regions :**

Geology of the Black Hills of Dakota, 4 vols., and atlas.  
Geology of the High Plateau of Utah, 4 vols., and atlas.

**Yellowstone National Park :**

Annual report of the superintendent for 1880. 8vo. Paper.

*Department of Justice.***Attorney-General:**

Official Opinions of the Attorney-General of the United States,  
vols. xv and xvi. 8vo. Paper and sheep.

*Navy Department.***Register of the Officers of the Navy, Marine Corps, etc.:**

June 1, 1880. 8vo. Paper.

January, 1881.

July, 1881.

**Circular No. 13. 4to. Paper.****Bureau of Construction and Repair:**

Allowances established under the bureau, 1881. 4to. Paper.

**Bureau of Equipment:**

Allowances established under the bureau, 1880. 4to. Paper.

**Bureau of Medicine and Surgery:**

Information and Guidance, Jeanette Expedition. 8vo. Paper.

Report on Yellow Fever in the U. S. S. Plymouth. 8vo. Paper.

**Naval Academy:**

Annual Register, 1880-'81. 8vo. Paper.

Catalogue of Specimens added to the Cabinet. 8vo. Paper.

**Bureau of Navigation, Hydrographic Office:**

American Practical Navigator. 8vo. Sheep.

Arctic Azimuth Tables. 8vo. Paper.

Charts and Plans published and withdrawn, March 31, 1881. 8vo.  
Paper.

Charts and Plans published and withdrawn, June 30, 1881. 8vo.  
Paper.

Hydrographic Notices for 1880 and 1881, and Index for 1881. 8vo.  
Paper.

**Lists of Lights:**

Atlantic, Gulf, and Pacific Coasts of the United States. 8vo.  
Paper.

Coast of Africa. 8vo. Paper.

East and West Coasts of North and South America. 8vo. Paper.

South Coasts of Asia and Africa. 8vo. Paper.

New Lights, United States and South America. 8vo. Paper.

Notices to Mariners for 1880 and 1881. 8vo. Paper.

Sailing Directions for Kattegat Sound, etc. 8vo. Paper.

**Nautical Almanac Office:**

Astronomical papers prepared for the use of Nautical Almanac.  
4to. Paper.

**American Ephemeris and Nautical Almanac:**

1882. 8vo. Paper.

1883. 8vo. Paper.

1884. 8vo. Paper.

Gauss' method of computing secular perturbations, etc. 8vo. Paper.

**Bureau of Steam Engineering :**

- Experiments on relative merits of screw propellers. 8vo. Paper.
- Report on the Herreshof system of Motive Machinery. 8vo. Paper.
- Report on the Machinery of the "Anthracite." 8vo. Paper.
- Report on the Standard Gauge for Bolts, Nuts, and Screw-threads. 8vo. Paper.

*Post-Office Department.*

- List of Post-offices of the United States, February 1, 1881.
- Bulletin, City Post-Office, Washington, D. C., 1881. 8vo. Paper.

*Smithsonian Institution.***Bureau of Ethnology :**

- Collection of Gesture Signs. 4to. Paper.
- Study of Mortuary Customs. 4to. Paper.

*Department of State.***Commercial Relations of the United States :**

- No. 2, November, 1880. 8vo. Paper.
- No. 3, January, 1881. 8vo. Paper.
- No. 4, February, 1881. 8vo. Paper.
- No. 5, March, 1881. 8vo. Paper.
- No. 6, April, 1881. 8vo. Paper.
- No. 7, May, 1881. 8vo. Paper.
- No. 8, June, 1881, and index. 8vo. Paper.
- No. 9, July, 1881. 8vo. Paper.
- No. 10, August, 1881. 8vo. Paper.
- Register of the Department of State, December, 1880. 8vo. Paper.
- Result of Investigation "American Pork." 8vo. Paper.
- Regulations for the use of the Consular Service. 8vo. Paper.

*Treasury Department.***United States Coast Survey :**

- Atlantic Coast Pilot, Boston to New York. 8vo. Paper.
- Deep-sea Soundings and Dredgings on Board the United States Coast Survey Steamer Blake. 4to. Paper.
- Methods and Results; general properties of the equations of steady motion. 4to. Paper.
- Tide Tables :
  - For the Atlantic Coast, 1881. 8vo. Paper.
  - For the Atlantic Coast, 1882. 8vo. Paper.
  - For the Pacific Coast, 1881. 8vo. Paper.
  - For the Pacific Coast, 1882. 8vo. Paper.

**Light-House Board :**

- Annual report for the year 1880. 8vo. Paper.
- Laws and regulations relating to the Light-House Establishment of the United States. 8vo. Paper.

**Bureau of Statistics :**

Merchant Vessels of the United States. 8vo. Paper.

Classification of imports entered for consumption in the United States, July 1, 1881. 8vo. Paper.

Quarterly reports relative to the imports, exports, immigration, and navigation of the United States, Nos. 2 and 3. 8vo. Paper.

Summary statements of the imports and exports of the United States, Nos. 8, 9, 10, 11, and 12, for 1880-'81, and No. 1, for 1881-'82. 4to. Paper.

**Life-Saving Service:**

Annual report for the year ending June 30, 1880. 8vo. Paper.

**Bureau of the Mint:**

General instructions and regulations in relation to the transaction of business at the mints and assay offices of the United States. 8vo. Paper.

**Internal Revenue Office :**

Internal Revenue Laws. 8vo. Paper.

**Inspector-General of Steam Vessels :**

Annual report to the Secretary of the Treasury for the year ending June 30, 1880. 8vo. Paper.

**Marine Hospital Service:**

Annual report of the Supervising Surgeon-General for the fiscal year 1880. 8vo. Paper.

**Board of Supervising Inspectors of Steam Vessels :**

Proceedings of special meeting of the board, May, 1880. 8vo. Paper.

Proceedings of the twenty-ninth annual meeting of the board, January, 1881. 8vo. Paper.

*War Department.*

Official Army Register, January, 1881. 8vo. Paper.

Notes illustrating the military geography of the United States. 8vo. Paper.

Articles of War governing the armies of the United States. 8vo. Paper.

The War of the Rebellion: A compilation of the official records of the Union and Confederate armies. Series 1, vols. 1 and 2. 8vo. Cloth and paper.

**Adjutant-General's Office :**

General orders for the year 1880 (in part). 8vo. Paper.

General orders for the year 1881 (in part). 8vo. Paper.

Orders (general courts-martial) for the year 1880 (in part). 8vo. Paper.

Orders (general courts-martial) for the year 1881 (in part). 8vo. Paper.

**Engineer Bureau :**

- Catalogue of the library of the Engineer Department. 8vo. Paper.
- Decrease of water. Translation of a lecture. 8vo. Paper.
- Geological exploration of the forty-fifth parallel. (O. King), vol. vii. Odontothornites. 4to. Cloth.
- Improvement of the Danube at Vienna. Translation of lectures. 8vo. Paper.
- Lists of reports and maps of the United States geographical surveys west of the one hundredth meridian. (Capt. George M. Wheeler in charge.) 8vo. Paper.
- List of maps etc., sent to the Geographical Congress at Venice. 8vo. Paper.
- Notes on the Pointe de Grave, Gironde River, France. 8vo. Paper.
- The water jet as an aid to engineering. 8vo. Paper.

**Judge-Advocate-General :**

- Digest of Opinions with notes. 8vo. Paper.

**United States Military Academy :**

- Annual Report for the year 1880. 8vo. Paper.
- Blasting or military mining. 8vo. Paper.

**Military Railroads :**

- Orders issued during the years 1861-1866. 8vo. Paper.

**Quartermaster-General :**

- Transportation of troops over the Atchison, Topeka and Santa Fé Railroads in 1875-76. 8vo. Paper.

**United States Signal Office :**

- Daily bulletin of the weather reports:
  - July 18, 1877. 4to. Paper.
  - August, 1877. 4to. Paper.
  - September, 1877. 4to. Paper.
- Rains and dry winds. 8vo. Paper.

**Surgeon-General's Office :**

- Index catalogue of the library of the Surgeon-General's Office, vols. 1 and 2. 4to. Cloth.

## REPORT OF THE ASSISTANT DIRECTOR OF THE UNITED STATES NATIONAL MUSEUM, FOR THE YEAR 1881.

Prof. SPENCER F. BAIRD,

*Director United States National Museum :*

SIR: In compliance with your instructions, I submit a report upon the present condition of the National Museum, and upon the work accomplished in its various departments during the year 1881.

On the 1st of July, letters of appointment were issued by you to all the officers and employees of the Museum, and at this time I was assigned to duty as executive officer of the Museum and curator of the department of arts and industries. The new building was not, however, ready for occupation until October, and the work of the year must be regarded as having been almost entirely of a preliminary nature. Owing to the fact that the work of reorganization was begun so late in the year, and that the curators of several departments did not enter upon their duties until autumn, it has been found impossible to present a special report from each department. It is respectfully suggested that in future the report of the assistant director shall relate to the work of the administrative department and other matters directly under his supervision, and that the operations of the departments be reported by the several directors in charge.

Very respectfully,  
G. BROWN GOODE,  
*Assistant Director.*

*March 1, 1882.*

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*Periods in the history of the Museum.*—The history of the National Museum may be divided into three periods: First, that from the foundation of the Smithsonian Institution to 1857, during which time specimens were collected purely and solely to serve as materials for research, no special efforts being made to exhibit them to the public or to utilize them except as a foundation for scientific description and theory. Second, the period from 1857, when the Institution assumed the custody of the "National Cabinet of Curiosities," to 1876. During this period the Museum became a place of deposit for scientific material, which had already been studied, this material, so far as convenient, being exhibited to the public, and, so far as practicable, made to serve an educational purpose. Third, the present period, beginning in the year 1876, in which interval the Museum has entered upon a career of active work, in gathering collections and exhibiting them on account of their educational value.

In the first period, the main object of the Museum was scientific re-



search; in the second, the establishment became a museum of record as well as of research; while in the third period is growing up the idea of public education. As soon as the material already within the walls of the Museum can be displayed in accordance with the plan already perfected, the National Museum of the United States will have commenced to fulfill all the demands which are likely ever to be made upon it.

*Museums for Record, for Research, and for Education.*—These three, co-operative and mutually helpful as they are, are essential to the development of any comprehensive and philosophically organized museum. Materials are gathered together that they may serve as a basis for scientific thought. Objects, which have served as a foundation for scientific study, or which, from their historical significance, are treasured up and preserved from destruction that they may serve purposes of record, permanent land-marks of the progress of the world in thought, in culture, or in industrial achievement; not only are they records of what has been done in the past, but they constitute the most valuable of all materials for future study. The museum of record, then, is not only an accessory to the museum of research, but an adjunct which accomplishes similar and fully equal results in the same direction.

The contents of the museum of research and the museum of record, if no other objects are sought but those already mentioned, might without impropriety be stored away in vaults and cabinets, inaccessible to any except the specialist. To give them their highest value, however, they should be arranged in such a manner that hundreds of thousands of people should profit by their examination instead of a very limited number, and that they should afford a means of culture and instruction to every person, young or old, who may have opportunity to visit the place in which they are preserved.

*The Museum of Record* is, in part, a necessary result of the museum of research, but its ultimate origin can without doubt be recognized at a very much earlier period in the treasure-houses of monarchs, such as are found recorded in the histories of very early days. The treasure-house of King Ahasuerus was one of the earliest museums, and the palace of Ptolemy at Alexandria was a prototype of the modern museum of art and industry. With the growth of republican ideas, treasures of this description have become national museums—as in the case of the museums of Saxony, Bavaria, Italy, France, and other European nations—which are in the main made up of materials which in former days were kept within the walls of palaces and were inaccessible to the public. Ecclesiastical edifices, too, have always been depositories for works of art and curious manufacture. The temples of Athens, Ephesus, and Delphi were art-museums, and so are many European churches of to-day. With the growth of liberal government, more liberal and comprehensive ideas as to the use and value of such materials have sprung up, and they are now recognized to be the property of the people of the

nation. Private individuals have often devoted themselves to the accumulation of collections which, either by design or in obedience to a natural law recognized and sometimes expedited by museum officers, have found a resting-place in public halls. The Ashmolean Museum at Oxford was the result of Sir John Tradescant's life-long toil.

*The Museum of Research* seems to have originated within the last three or four centuries, and, perhaps, to have been one of the results of the promulgation of the inductive philosophy. The collections gathered by Linnæus, those of Sir Hans Sloane, which formed the nucleus of the British Museum, and of Buffon, Cuvier, and their collaborators, as a beginning of the Natural History Museum of Paris, were among the earliest of this class.

*The Educational Museum* is of much more recent origin, and may be considered as one of the outgrowths of the modern industrial exhibition. The World's Fair of London in 1851, the first of a long series of international exhibitions, was utilized by the Government of Great Britain as a starting-point for a number of national and educational museums, the most perfect which have as yet been organized, and the subsequent World's Fairs have been utilized in a similar manner, so that nearly every civilized country now has museums of this description.

The systematic exhibition of the products of the earth and the achievements of human industry for the instruction of visitors, the improvement of the public taste, and the fostering of arts of design had not been attempted, probably scarcely thought of, thirty-two years ago.

The gradual deterioration of industrial exhibitions and World's Fairs, the predominance of purely commercial features in those which have been attempted of late years, the growing difficulty in securing the attendance of exhibitors would seem to indicate that their period of greatest usefulness is in the past.

The present demand is for something better, more systematic, more definitely instructive in its aims—something which shall afford the same long vistas into the palaces of nature and art, and at the same time provide guide-marks to explain their meaning.

*Effects of the Centennial Exhibition of 1876.*—One of the results of the Philadelphia Exhibition of 1876 is that it made plain to the people of the United States the educational importance of a great industrial museum. It suggested to the observant the thought that if so much that is inspiring and instructive could be imparted by a collection of objects gathered together chiefly with commercial ends in view on the part of the exhibitors, necessarily somewhat unsystematically arranged, and with little effort toward labeling in an instructive manner, an immense field was open for educating the public by gathering together a selected series of similar objects, which could be so classified and explained by means of labels and guide-books that they should impart a consistent and systematic idea of the resources of the world and of human achievement.

The United States has, as yet, no comprehensive educational museum, although there are several museums of limited scope, which have successfully carried out the educational idea in the arrangement of their materials; for instance, the Boston Museum of Art, the Metropolitan Museum of Art in New York, the Pennsylvania Museum of Industrial Art, the Peabody Museum of Archæology in Cambridge, the Peabody Museum of Yale College, and the Boston Society of Natural History.

The same remark applies with equal force to the museums of Europe. There are certain institutions, like the Museum of Practical Geology, the museums of the Royal College of Surgeons, the museums at Bethnal Green and South Kensington, in London, the Museum of Industrial Art at Berlin, the Ethnological Museum at Leipsic, the National Museum of Germany at Nuremberg, the Bavarian National Museum at Munich, and others, which have admirably carried out a single idea, or a limited number of ideas, and which are marvelously rich in material and arranged in a manner full of suggestiveness. It may safely be said, however, that all the museums of anthropology, economy, and industrial art now in existence are, either by design or chance, limited in their scope.

The museum is yet to be organized which shall show, arranged according to one consistent plan, the resources of the earth and the results of human activity in every direction. This has not yet been done, even for a single country.

There can be little question that the National Museum of the United States can be made, in the course of a few years, the most comprehensive and instructive museum in the world. While it may not be possible to gather together such treasures of art and industry as are in the possession of the government museums of Europe, it is not unreasonable to hope that examples of every kind of object known to man may be acquired, and that this museum may be able, by means of a thorough classification, and as a result of the absence of the enormous masses of duplicates, which are sure to incumber any old museum, to illustrate the history of human culture better than has ever before been done.

The educational museum being, as has been already remarked, of comparatively recent origin, and the efforts of thoughtful men in times past having been chiefly directed toward the building up of museums of research, it is not at all strange that natural-history museums should be so common, while museums illustrating the history of mankind are so rare. The importance of the natural history museum from the stand-points of science and industry can scarcely be overrated. A museum of culture must, however, be admitted to possess equal importance to the philosopher and to be of greater value for the education of the public at large.

The majority of visitors to any museum go thither in search of amusement, or from a mere idle curiosity. Many have no desire to gain instruction, and most of those, if actuated by such a desire, fail to accom-

plish their object by a visit to the ordinary museum. This is due, in part, to the fact that so much duplicate material is exhibited that the really instructive objects are lost to view; in part, to the fact that the objects in but few museums are labeled in a really instructive manner, and principally to the fact that the objects exhibited are not of the kind best adapted to the needs of the museum-visiting public. The visitors carry away only a general impression of rooms full of glass cases containing animals, minerals, or "curiosities," gathered by travelers among uncivilized races. Professor Huxley has defined a museum as "a consultative library of objects"; and this definition, true enough in itself as a description of the best ideal museums, unfortunately is too true a description of all. Most museums are as useless and little instructive as are our libraries of consultation to the great masses of our people, who know not how to use them. The *educational museum* should be more like a popular encyclopedia than like a library full of learned tomes. The *museum of research*, since it is intended chiefly for investigators, should be the consultative library.

To obviate these difficulties many steps must be taken which are not usual in museums. By far the most important of these is in the direction of thorough labelling.

An efficient educational museum, from one point of view, may be described as *a collection of instructive labels, each illustrated by a well-selected specimen.*

There is a certain peril in the attempt to build up a museum upon this basis. Museums which exhibit only such objects as are in themselves beautiful or marvellous cannot fail to be attractive, no matter how poorly the objects are arranged and labelled.

When, however, the objects depend for their interest upon the explanations or the labels, and upon the manner in which they are placed, relatively to each other, a responsibility a hundred-fold greater is entailed upon the curators. The materials of such a museum may be compared to piles of brick, stone, lumber, and architectural ornaments, which by themselves possess little apparent interest, but which may by thought and labor be combined into an imposing and useful edifice.

*Principles to be followed.*—Certain cardinal principles may be announced which should be considered in the arrangement of every public museum: (I) every article exhibited should illustrate an idea, and no two objects should be shown which illustrate the same idea in a similar manner; (II) the idea which any object is intended to illustrate should be explained upon its label in such a manner that any intelligent visitor, without previous special knowledge of the subject, may be able to learn (*a*) why the object is shown, and (*b*) what lesson it is intended to teach; (III) the objects should be so carefully classified that their relations to each other may be recognized by the visitor, so that, taken together, they suggest certain general conclusions; in the formation of these conclusions he should be aided by certain general or col-

lective labels which relate to and describe groups of objects in a manner similar to that in which the individual labels describe separate articles; (IV) the labels individual and collective, should be supplemented by guide-books and manuals for special departments, which shall contain all the information given upon the labels arranged systematically, and which shall be illustrated by engravings of the more important objects.

Industrial museums, as a rule, exhibit only those articles which are designed and constructed in the most sumptuous manner—the armor of kings and knights, the furniture of palaces, the most artistic of metal work, stone work, and wood work. The ethnological museums, on the other hand, admit only the implements and costumes of savage and partially civilized races. Between the two there is a great chasm to be filled. Is it not as important to preserve in museums the more humble and simple objects which illustrate the domestic economy and customs of the masses of the people of civilized nations, as to search for similar objects in distant lands, or to treasure up only the objects which, on account of their cost, are seen and used only by the most wealthy and luxurious classes in the civilized community? A museum which attempts to show the evolution of civilization, should preserve the simplest products, the every-day costumes, together with the tools and appliances which have been in common use by civilized man in the present and past centuries.

Such objects have at least as much claim to careful preservation as similar objects gathered in distant lands; for, although the latter are at present more interesting on account of their strangeness, a century hence they will be far less interesting than the objects which are in common use in our own country at the present day.

It has long been one of the standard instructions given to persons charged with collecting specimens for the Smithsonian Institution, that, in whatever locality they may be, they shall collect the more diligently those things which are most common, paying but very little attention to objects which may there be very rare, since these same objects are sure to be common in some other locality, where they can be obtained with greater ease. A similar practice should be followed in gathering objects for an industrial museum. American ethnologists have done well in devoting their energy to gathering the manufactures of the North American Indian, for the products of their race would otherwise have been, for the most part, lost to mankind. At the same time, much that is of equal or greater importance belonging to our own ancestors has been allowed to go to destruction; and we have but few illustrations of the costumes and customs of the two preceding centuries of American history, except such as are preserved in books and pictures.

To supply the place of objects too large to be placed in a museum, too evanescent to have been preserved, or which, on account of their rarity or neglect in preserving them at the time when they could have been obtained, are necessarily lacking in the collections, it is essential that

museums should assume the administration of great quantities of material such as is usually consigned to the library or to the picture-gallery. Otherwise, deficiencies in groups of objects, which should illustrate by their collective meaning a general idea, will much impair their value. Pictures and diagrams should be freely used as temporary or permanent substitutes for specimens which may be lacking, and also to supplement and explain the descriptive labels. In many sections it may be impossible to exhibit anything but pictures. It is needless to point out the difference in the influence of a series of plates, like those, for instance, in Audsley and Bowes, "Keramic Art in Japan," the publications of the Arundel Society, or in Watson's work on "The People of India," displayed in a public museum, where they are seen daily by thousands of visitors, or hidden except from the initiated few in a library, where they are accessible practically to students only with abundance of time and training in the use of books.

Much of the material usually shown in art galleries and art museums, such as is ordinarily used to illustrate the history of art, or is preserved on account of its artistic suggestions, may be displayed in a much more instructive manner in a museum without in the least lessening its value to the artist or designer. Portraits, pictures of buildings, of costumes, of geological features in scenery, of ceremonies, and of social customs may be arranged and administered just as if they were specimens. It is even desirable to exhibit in the cases with the specimens books relating to their history; for it is useful to familiarize the public with the appearance of their bindings and types. For instance, a collection of the standard works on numismatics, shown in a case adjoining a collection of coins, would have a decided educational value, giving to the public information which they would otherwise have to seek from the curators, if indeed it would appear to them worth while to take the trouble to seek such information, or they should succeed in overcoming the natural hesitation to become questioners. In addition, much might be accomplished by having standard works, relating to the special departments of the museum, placed in convenient places in the exhibition halls, and, if necessary, fastened to desks in such a manner that they could not be removed, while easily accessible to any person who might wish to become informed upon special topics relating to objects being examined.

The International Exhibition of 1876 was the beginning of a new period of activity for the National Museum. Before 1876 no money had been expended in the increase of the collections. In 1875, however, Congress voted certain sums, to be expended under the direction of the Smithsonian Institution, for the illustration of the animal and mineral resources of the United States; under the direction of the Fish Commission, for the display of the fishery resources of the country; and under

the direction of the Indian Bureau and the Smithsonian, for the illustration of the ethnology of the aborigines of North America. At this time a great quantity of valuable material was obtained which, in connection with material borrowed from the National Museum, served to carry out very thoroughly the desire of Congress in making the appropriation. At the same time the Museum became possessed of a large portion of the industrial exhibits of some thirty foreign governments which participated in the exhibition of 1876, and since that time very important additions and contributions have been received from private exhibitors, American and foreign, of materials shown by them in the same exhibition, and in the so-called permanent exhibition, which was its temporary successor.

The new building, which was put up expressly for the reception of these collections, has proved to be so well adapted for the reception of a great industrial Museum, that many manufacturers and commercial houses have been induced to contribute materials for its expansion, and there is every prospect that the Museum will develop into one of the most perfect and comprehensive of its class.

This Museum being by law the only legal depository for all objects of art, and of all objects of natural history, and of all geological and ethnological specimens belonging, or hereafter to belong, to the United States, or gathered by any branch of the public service, and being by law and by inheritance the successor of the National Cabinet of Curiosities and of the National Institution, the only similar establishments which have ever existed in the United States, and having, after a quarter of a century, been sustained by annual appropriations from Congress, would seem to be entitled to the hearty support of the government in its efforts to gain an honorable place among the National Museums of the world, and, if possible, to surpass them in completeness and attractiveness.

It is hoped that in the future the public spirit of many citizens of the United States will lead to the deposit in the National Museum of many of the extensive private collections now so rapidly increasing throughout the country in number and extent.

It should be the aim of the officers of the Museum to encourage such deposits, by using the most thorough and painstaking methods in installing and caring for the specimens under their charge.

Mr. Barnet Phillips, discussing in the New York Times the future prospects of the Museum, writes:

"It does not, of course, behoove a great national enterprise of the character I have tried to describe to play the part of a solicitor, nor can it go from collector to collector and beg for contributions for its cases. Still, without directly asking such an enlightened mass of people as our own, it counts a great deal on private support. It believes that there are many people in this country—men of means, of intelligence—who, if they understood what is the aim of this Museum—that of national education—would gladly send to it their collections; or, knowing what particular class of objects the institution was desirous of securing, would come forward spontaneously and give it their aid."

*Plan of organization.*—The chief requisite to success in the development of a great museum is a perfect plan of organization and a philosophical system of classification. Much thought has been devoted to these subjects by the officers of the Museum, especially during the past two years. Many of the principal museums of Europe have been studied by me, personal visits having been made, their catalogues and publications minutely compared, and correspondence carried on with their officers. It is hoped that the plans which have been developed as the result of these labors, may include the best features of similar plans hitherto proposed.

The general idea of the new classification is that the collections should form a museum of anthropology, the word "anthropology" being applied in its most comprehensive sense. It should exhibit the physical characteristics, the history, the manners, past and present, of all peoples, civilized and savage, and should illustrate human culture and industry in all their phases; the earth, its physical structure and its products, is to be exhibited with special reference to its adaptation for use by man and its resources for his future needs. The so-called natural history collections—that is to say, the collections in pure zoology, geology, and botany,—should be grouped in separate series, which, though arranged on another plan, shall illustrate and supplement the collections in industrial and economic natural history.

The classification proposed should provide a place for every object in existence which it is possible to describe, or which may be designated by a name. When the object itself cannot be obtained, its place should be supplied by a model, picture, or diagram.

The following plan of classification is proposed for provisional use; the experience of future years will doubtless make it wise to introduce into it numerous changes. Whatever may be its faults, it is believed that any object which may come into the possession of the Museum may by its means be at once assigned to a place in which it may consistently remain.

Only the principal divisions of the classification are now presented, a more detailed exposition being reserved for the next report.

#### OUTLINE OF A SCHEME OF MUSEUM CLASSIFICATION.

Divisions.	Classes.
I. Mankind .....	1- 3
II. The Earth as Man's Abode.....	4-10
III. Natural Resources .....	11-15
IV. The Exploitative Industries .....	16-20
V. The Elaborative Industries.....	21-38
VI. Ultimate Products and their Utilization.....	39-47
VII. Social Relations of Mankind ....	48-54
VIII. Intellectual Occupations of Mankind.....	55-64



## ANALYSIS.

I.—*Mankind.*—(*Anthropology.*)

1. Man as a zoological unit.....Somatology and psychology.
2. Man, grouped in peoples or races. (*a*) Races of men, physical characters; (*b*) linguistic characters; (*c*) art and industrial characters; (*d*) ethnogeny; (*e*) geographical distribution of races; (*f*) history, prehistoric and recent, &c.
3. Man, in individual manifestations....Representative men: Biography.

II.—*The earth as man's abode.*—(*Hexiology.*)

4. The earth, in the solar system .....Cosmology.
5. The earth's structure .....Geology.
6. The features of the earth's surface...Physiography.
7. The atmosphere and its phenomena.Meteorology.
8. Effects of man upon the earth's sur- Man and nature.  
face, and of climate, physical  
features, &c., on man.
9. Apportionment and nomenclature Geography.  
of the earth's surface.
10. Exploration of the earth .....Voyages and travels.

III.—*Natural resources.*—(*Force and matter.*)

11. Force in its manifestations .....Physics, mechanics, and  
physiology.
12. The elements and their combina- Chemical collections.  
tions.
13. Inorganic matter .....Mineralogical collections.
14. The vegetable kingdom .....Botanical collections.
15. The animal kingdom.....Zoological collections.

IV.—*The exploitative industries.*—(*Exploitative technology.*)*Primary.*

16. Exploitation of inorganic materials..Mining and quarrying.
17. Exploitation of vegetable products Lumbering and field-glean-  
of spontaneous growth. ing.
18. Capture of animals.....Hunting, fishing, &c.

*Secondary.*

19. Culture of plants.....Agriculture, horticulture,  
and forestry.
20. Culture of animals: domestic ani- Pecudiculture.  
mals and their uses.

V.—*The elaborative industries.*—(*Elaborative technology.*)

21. Preparation of food-stuffs, narcotics, &c.
22. Distillation, manufacture of perfumeries, &c.

V.—*The elaborative industries*—Continued.

23. Oils, fats, soaps, and waxes; their preparation and use.
24. Gums, resins, glues, and cements.
25. Pigments and dyes; painting, staining, polishing, bleaching, &c.
26. The chemical manufactures and their products.
27. Feathers, hair, bristles, and their use.
28. Furs and leathers; tanning and currying.
29. Fibers, cordage, textile fabrics, needlework, basket-work.
30. Paper and its manufacture; book-making; stationery.
31. Hard and flexible organic tissues and their use.
32. Woods, and their wood-working industries.
33. Stones, and the stone-working industries; masonry.
34. Metals, metallurgy, and the metal industries.
35. Glass and enamel and their fabrication.
36. Pottery, and the ceramic industry.
37. Tools, machinery, and motors, their manufacture and use.
38. Construction, architecture, and civil engineering.

VI.—*Ultimate products and their utilization.*

39. Foods and drinks: preparation, cookery, &c.
40. Narcotics and masticatories; pipes, &c.
41. Dress, and personal adornment.
42. Buildings, villages, and cities.
43. Furniture, house interiors, domestic economy, &c.
44. Heating and illumination.
45. Medicine, surgery, pharmacology, hygiene, &c.
46. Public comfort, recreation, protection, and rescue.
47. Transportation by land and water: appliances and accessories.

VII.—*Social relations of mankind.*—(*Sociology and its accessories.*)

48. The vocations of men.
49. Communication of ideas and their record: writing and printing, telegraphy, signals, &c.
50. Trade and commerce.
51. Societies and federations, social, beneficial, religious, and political.
52. Government and law.
53. War (including armor and weapons).
54. Festivals, ceremonies, usages, memorials, &c.

VIII.—*Intellectual occupations of mankind.*—(*Art, science, and philosophy.*)

55. Games and amusements.
56. Music and musical instruments.
57. The drama and the stage.
58. The pictorial, plastic, and decorative arts.
59. Literature (from the intellectual standpoint only).
60. Folk lore, traditions, and superstitions.

VIII.—*Intellectual occupations*—Continued.

61. Science: (Research and record.) Scientific instruments.
62. Philosophy, religious, metaphysical, and cosmical.
63. Education and reform; schools, museums, libraries, &c.
64. Climaxes of human achievement.

I. *Man*.—In the first division man is exhibited as the central *idea* of the whole system; (1) in a general way: his anatomical structure and physiological functions are graphically shown; (2) as divided into races; the physical, the linguistic, and industrial characteristics of each race and their geographical distribution and history are taken up; and, thirdly, man is shown in his individual manifestation by an exhibition of portraits and statues of the representative men of all countries and ages.

II. *The Earth*.—In the second an exhibition is made of the earth considered as man's abode. Viewing the earth as a member of the solar system, the principles of astronomy are illustrated; then are shown the structure of the earth, its geological history, its climate, and other features by means of which it is especially adapted for human occupation; and finally the changes which have been produced on the earth's surface by the agency of man and the whole subject of geography.

III. *Natural resources*.—In the third section are to be shown the resources of the earth in the form of minerals, plants, and animals, and its laws and manner of utilization.

IV. *Exploitative industry*.—In the fourth section are to be shown the methods and results of the industries of exploitation; such as quarrying, mining, hunting, fishing, agriculture, and the rearing of domesticated animals.

V. *The Elaborative industries*.—In the fifth section are to be included the constructive industries and arts and their products: the preparation and working of stone, brick, pottery, tiles, metal, glass, wood, textile fabrics, leathers, furs, paper, glues and cements, paints, dyes and varnishes, chemical materials, tools and utensils, food products, the graphic arts, architecture, engineering, &c.; and the final products of these arts and industries in their primary condition and prepared for final utilization, as in the case of costume, edifices, furniture and domestic economy, vehicles of transportation, &c.

VI. *Physical condition of man*.—In the sixth section are to be illustrated those subjects which relate especially to the physical condition of man: heating and illumination, furniture, home customs, domestic economy, buildings, villages and cities, foods, dress, medicine, surgery, pharmacology, sanitary science and public health, gymnastics and physical culture, hospitals, and remedial asylums.

VII.—*Social relations*.—In the seventh section are to be shown the appliances and methods made use of by man in his social relations; the communication of ideas by writing, telegraphic signal, mails, &c., domestic and social customs and observations, societies and representative organizations, trade and commerce, government and law, ceremonial and war.

VIII.—*Intellectual occupation of man.*—In the eighth section are to be shown objects illustrating the intellectual and moral condition of man: superstitions, crime and error, benevolent enterprises and reformatory institutions, religious organizations and systems, museums, sports, the pictorial and plastic arts, music and musical instruments, the drama, folk-lore, literature, science, philosophy, education and educational institutions, and the most perfect results of human achievement in every direction of activity.

*Possibilities of expanding the above plan.*—The above statement of the plan of classification, on account of its brevity, fails to give a very definite idea of the comprehensiveness of the scheme. In each division of the subject, plans have been devised for showing not only the present condition of the achievement, but the steps by which man has arrived at the present condition in every direction in which human activity has been exerted—a graphic history of the development of human culture and civilization.

*E. g., Expansion of culture of animals.*—As an illustration of the manner in which each section of this classification may be expanded, reference may be made to two or three divisions. Under the head of culture of domestic animals, for instance, would be shown the methods employed in the culture of sponges, of oysters, of leeches, of bees, of the cochineal insect, of silkworms, of maggots for bird food, of crawfish, crabs and lobsters; of fish, of poultry, of singing and ornamental birds, of fleece-bearing animals, of meat and milk producing animals, of beasts of burden, hunting animals, of pets, and the subjects of aquaria, menageries, and zoological gardens. In connection with these would be exhibited a collection of all the animals which have been domesticated by man in any part of the world, some eighty or ninety species altogether, and in the case of the more prominent species—for instance, the dog—characteristic illustrations of each breed or race.

*E. g., Expansion of transportation.*—In the division of transportation would be shown all that related to modes of movement, roads, tramways, canals, railroads, lines of ocean and river navigation, with the accessories of tunnels, bridges, toll-gates, sign-posts, buoys, light-houses, &c., and vehicles of transportation, from the skate, stilt, snow-shoe, velocipede, and sledge, to the railroad-car, the steamer, and the balloon.

*E. g., Expansion of graphic arts.*—Under the head of the graphic arts would be shown, in addition to illustrations of all the various methods of engraving upon stone, wood, and metal, of painting and photography, a collection illustrating the art of writing and printing from its inception—from the stilus and papyrus—through the pen and pencil to the type-writer, electric pen, the hektograph, and the whole subject of book-making, printing with engraved types and blocks, with movable types, wood-cuts, metal plates, and lithographic stone, the details of book-making, proof-reading, and book-sizes of books, &c.

*E. g., Expansion of ceremonies.*—Under the head of ceremonies, the

exercises of religious rites, and social ceremonies, would be shown ecclesiastical utensils, &c., monuments of all kinds, badges of office, flags and banners, heraldic emblems, and regalia, medals, &c.

Each of the sixty-four principal sections provided for in the classification is expanded in an equally comprehensive manner.

*Experiments in methods of arrangement.*—Much has been done during the year in studying and experimenting, for the purpose of ascertaining how to present to the public in the most effective manner the specimens to be shown in the Museum; the main objects in view being, (1) to enable the visitors to make their examinations with the least possible fatigue of eye and limb; (2) to label the objects in the most concise and instructive manner, and (3) to make the Museum as a whole as beautiful and attractive as possible.

The new building more than meets all expectations. The illumination is perfect, the amount of space available for exhibition purposes is undoubtedly the maximum for a building of the size, and the disposition of the exhibition halls in a single level directly upon the surface of the earth, proves to be of great importance both to visitors and to those who have in hand the work of arranging the collections. Over two hundred exhibition cases have been constructed, many of which embody ideas which have never before been used in museum administration; these, however, must be seen to be appreciated. The cases are all of mahogany, finished in the natural color, and have been constructed in accordance with artistic plans furnished by Mr. W. Bruce Gray. Their chief recommendations are the following: (1) the building consisting practically of a single large hall; the cases are so constructed as to form partitions dividing the hall into seventeen halls of lesser extent; (2) the cases are all of one length, 8 feet 8 inches, which is the architectural unit of the Museum building, or are of such lengths that, combined together, they always conform to this unit, so that they are interchangeable; (3) the construction is such that, with very slight expenditure of labor, any one of them full of specimens can be transported from one part of the building to another, thus allowing great freedom in the matter of rearranging the museum; (4) all the smaller specimens are mounted in groups upon small tablets or in glass-covered boxes of uniform size, which can be handled with great facility and which afford great security to the specimens, and diminish immensely the labor of properly caring for them; (5) the objects are displayed against backgrounds which at the same time afford the greatest ease to the eye of the visitor and the greatest relief and effectiveness to the object displayed; (6) the objects being shown singly against a suitable background, and at the same time brought as close as possible to the glass front of the case, the sense of confusion, so often experienced in museums, is entirely avoided; (7) the labels are printed in large, heavy-face type and upon paper of soft tints, which are much less wearisome to the eye than the ordinary labels in black and white.

*Aid from other Museums.*—Many important suggestions have been received from the management of the South Kensington Museum, undoubtedly the most perfect and artistically arranged museum in the world, the director of which has with great courtesy furnished a complete set of samples of mounting materials and labels and plans of all the exhibition cases.

Similar aid has been furnished by Dr. Günther, keeper of the zoological department of the British Museum, and by architectural counselor Tiede, who has supplied plans of the Zoological Museum at Berlin, of which he is the architect, as well as of other museums in Europe. Experiments have been made with the idea of building the exhibition cases of iron, and of finishing the wooden cases in ebony color, but the cases of mahogany, polished in the natural color of the wood with a "rubbed hard-oil finish," seem to be at once the most beautiful and the most convenient.

Only a limited number of cases of each pattern have been constructed, and the work has been given to nine different manufacturing firms in Washington, Baltimore, and Philadelphia. The experience which has been gained by the experiments of the past year will enable the officers of the Museum to proceed understandingly and rapidly with the work of completing the installation of the new building with cases. There are now on hand in the two buildings about 600 exhibition cases. Many of these will, however, require to be replaced in the future.

One of the exhibition halls in the old Smithsonian building has been refitted with cases, and has been experimentally decorated from a design gratuitously furnished by W. B. Gray, the work being done by the well-known firm of John Gibson & Co., of Philadelphia, at exceptionally low rates.

*Museum Library.*—The increased activity in investigation, as well as the needs of the curators in their work of recording the history of the collections under their charge, has made it necessary to establish a working library in connection with the Museum, it being found impossible to depend upon the old method of drawing books from the Congressional Library. A small number of works has been reclaimed from the Smithsonian deposit in the Congressional Library, but the Museum Library is, for the most part, made up of a very valuable collection of standard zoological and industrial works and bound pamphlets, composing the private library of Professor Baird, which he has given to the Museum.

In response to a special circular, many of the museums and scientific societies of Europe and America have contributed sets of their publications. The library now contains 5,450 volumes and 4,750 pamphlets, bound and unbound, in all a number of 10,200.\*

Books of reference, periodicals, and works of general interest are kept

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\* Estimate based on running count.

in the general library in the northwest corner of the Museum building, while those works relating to special departments are, for the convenience of workers, placed in sectional libraries in the apartments of the several curators. The library system has been under the charge of Mr. Frederick W. True, who has already completed a card catalogue of the books.

*Work of the Preparators.*—The work of the various preparators connected with the Museum has increased in efficiency during the year. Mr. Palmer, the chief modeller, has developed several new features in his work, one of the most important of which is the making in plaster the casts of animals, such as, on account of the shortness of their hair, cannot be successfully set up by the taxidermist. Experiments on dogs of different breeds and a leopard have been successful. A cast of a high-bred pointer is especially remarkable, on account of the faithful manner in which all of the marks of its hereditary perfections are shown, and on account of the life-like manner in which it is represented in the act of pointing. The largest animal cast, which has yet been made, is that of a fin-back whale, over 30 feet in length, one side of which exhibits the whale in the attitude of swimming, while upon the other, in the concavity of the inner outline of the half cast, is to be placed the articulated skeleton of the animal.

The artists, Messrs. Shindler and Hendley, have made many improvements in painting the casts of reptiles, fish, and stone implements, it being now possible to produce counterfeits of implements which cannot be distinguished from the originals, except by the test of the knife. In February of this year Mr. John H. Richard, the veteran zoological draughtsman, for several years in the employ of the Museum, died, at an advanced age. Among many important works illustrated wholly or in part by him were Holbrook's "Ichthyology of South Carolina," and "North American Herpetology."

Mr. Marshall, who has been employed entirely in mounting birds, manifests increased skill.

A number of mammals and skeletons have been mounted at the establishment of H. A. Ward, in Rochester, N. Y., usually with very satisfactory results.

The photographic gallery in the new building has been fitted up with the purpose of making it one of the most complete establishments for scientific photography.

A temporary force of stone cutters and polishers has been employed in dressing the collection of building-stones gathered in connection with the tenth census by Dr. Hawes, and 1,322 cubes have been finished.

Mr. George P. Merrill has been engaged in lapidary work in the same connection, and the microscopic slides of building-stones which he has prepared are considered to be as good as the best.

Detailed statements are on file showing the work accomplished by the several preparators.

*Details of administration.*—Much thought has been devoted during the year to the reorganization of the force of experts and workmen employed in the Museum, and with the beginning of the present fiscal year several of the principal assistants of the Museum were commissioned as curators, and were formally assigned to the charge of special departments.

A schedule has been drawn up by which the employés of the Museum are classified in a number of groups, each grade having certain responsibilities and a fixed salary attached to it. Hereafter, changes of salary can only be effected by a change of grade; and one source of dissatisfaction among the employés of the Museum in the past will by this arrangement be avoided. In several instances specialists have volunteered to perform the duty of curators without pay, for the sake of the opportunities of study which they would thus acquire, and have been appointed honorary curators.

Another task which has been accomplished is the formulation of the usages and unwritten laws of the establishment in systematic form. So long as the number of employés was small, this was, perhaps, unnecessary; but it has been of late found essential to have printed in accessible form a "plan of organization," which should define the duties of officers and employés in each grade, and should explain for their benefit the many forms of administration routine, the observance of which is so necessary for the efficiency of the Museum work.

One of the results of this new "plan of organization" has been the complete rearrangement of the offices and workrooms, in which specimens are received, unpacked, and from which they are distributed to the different departments, and of the storage-rooms and preparators' workshops.

Another result has been the establishment of the office of registrar, this officer being responsible for all matters relating to the reception and sending out of packages, the management of the storage-rooms, and the record and acknowledgment of accessions, the packing and unpacking of boxes.

The force of mechanics, watchmen, engineers and firemen, laborers, messengers, and cleaners has been reorganized, and is under the immediate direction of Mr. Henry Horan, superintendent of the building, under whose efficient management a high degree of efficiency and discipline has been attained.

Employés in this division have been required to assume a uniform cap of blue cloth, with the words "U. S. National Museum," and, in the case of the superintendent and master-mechanics, with the names of their offices in gold letters upon the front. This plan has proved practically a success, being a convenience to visitors and insuring better discipline. Complete reports of work accomplished in the departments of labor and service, in the engineers' and electricians' divisions are on file.

The electric service of the Museum has been much extended and im-



proved. The telephones, now in every department, afford opportunities of communication through the central office, which is in operation night and day. Wires have been carried from the central office to the residences of the Director and some of his principal assistants.

The public-comfort rooms for ladies and men, in the southeast pavilion of the new building, have been open since the time of the inauguration ball in March, 1881.

The visitors' book for 1880 shows 24,000 entries. These are believed to represent at least 150,000 visitors, it being a matter of observation that only about 10 per cent. of the visitors enter their names. A registering-machine is now in use, by which a careful record of the number of visitors is kept.

Plans for the better arrangement and preservation of the archives of the Museum have been perfected; and a large room in the northwest pavilion has been set apart as an archive-room. Here it is intended to concentrate all the papers illustrating the history of the Museum. In adjoining rooms will be stored the duplicate printed labels and samples of apparatus and other materials used in the Museum.

A job printing press, with an assortment of type, for printing labels and circulars, has been purchased during the year, with the view of saving time and affording opportunities for experimenting in the preparation of exhibition labels, which has hitherto been impracticable. All considerable jobs of printing are, however, as heretofore, done at the Government Printing Office.

*Publications.*—There has been much activity during the year in the direction of scientific investigation, and a considerable number of books and papers have been published by the officers, a list of which publications will be found in the bibliographical appendix, together with a list of papers, relating to the government collections, published by others than officers of the Museum. A number of important memoirs are in preparation—some of them already in the press—which cannot be included in the bibliography of 1881, but are referred to in a second supplement containing announcements of works in preparation.

In accordance with a rule of the Museum recently announced, officers of the Museum, or others, intending to use Museum material in the preparation of memoirs are required to file with the Director of the Museum a statement of their intention. This step has been found necessary in order to avoid collisions of interests.

It is intended at an early date to complete the Bibliographical History of the Museum—a work commenced some years ago by the present Director. This will form an exhaustive index to all that has been written concerning the government collection.

A bibliography of the publications of Prof. S. F. Baird, now in press, will serve as a first installment to this work, and in this connection is particularly appropriate, since he was really the first to begin the proper utilization of the material of the Museum.



The Biological Society of Washington has since October 1 held its monthly meetings in the archive room of the Museum. The average attendance at these meetings has been about 40; and many papers of importance have been presented, a considerable portion of which related to collections in the Museum.

It is intended to fit up one of the smaller ranges in the new building with chairs, in order that it may be used for meetings of this and similar societies, and for use as a lecture-room at such times in the future as it may be found desirable to have public lectures given in connection with the work of the Museum.

A table, prepared by Dr. Bean, showing the number of entries in the record books for the years 1880 and 1881 is presented below, and Appendix D a detailed alphabetical list of contributors to the Museum.

*Table showing the number of entries in the record books of the United States National Museum at the close of the years 1880 and 1881, respectively.*

Class.	1880.	1881.	Increase 1881.
Mammals .....	13, 264	13, 360	97
Birds .....	81, 829	85, 673	4, 845
Reptiles and amphibians .....	10, 517	12, 490	1, 974
Fishes .....	26, 947	29, 586	2, 639
Skeletons and skulls .....	16, 867	16, 610	244
Eggs .....	18, 189	18, 417	229
Crustaceans .....	2, 514	3, 678	1, 165
Annelids .....	100	100	.....
Mollusks .....	33, 169	33, 281	113
Radiates .....	3, 845	4, 703	1, 859
Sponges and protozoans .....	.....	700	700
Invertebrate fossils .....	9, 750	11, 478	1, 729
Minerals .....	20, 450	21, 552	1, 103
Building-stones .....	.....	2, 932	2, 932
Ethnological specimens .....	45, 570	51, 410	5, 841

Total increase, so far as entered in catalogue, 1881, 24,470.

The principal operations in the Museum during the year may perhaps best be described by a reference to what has been accomplished in each special department of work.

#### ART AND INDUSTRY.

In the department of art and industry there has been considerable activity, although the want of suitable exhibition cases has rendered it impossible to show many of its results to the public. The great mass of material acquired at the close of the Philadelphia Exhibition (which material has since been stored in the Armory building) has now been brought to the Museum and stored in two of the central courts. The collections of naval models and musical instruments and a portion of the Chinese collection have been put in order and are ready for exhibition.

**Materia Medica.**—The *materia medica* collections have been assorted and catalogued by Dr. J. M. Flint, surgeon, U. S. N., who has been detailed by the Surgeon-General of the Navy to superintend the work of building up this department of the Museum. During the year most of the drugs and medicines have been arranged, and the catalogue

shows 1,574 entries. Many of these are specimens of Chinese medicines and the remainder are the first installment of the gift of Messrs. W. H. Schieffelin & Co., of New York City, who have volunteered to furnish to the Museum a complete collection of the drugs now in use in the United States and Europe.

A very complete collection of the official pharmacopœias of all nations has been gathered, and Dr. Flint has undertaken the work of compiling from these, for use in the arrangement of the collections, a list of all the articles of the *materia medica* of the world and the authorized preparations of each.

*Foods.*—A considerable amount of work has been done upon the collection of foods by Prof. J. Howard Gore, who reports that there are now in the Museum 951 specimens belonging to this department, 225 from China, 516 from the Indians of North America, and 210 preparations of marine foods, gathered in connection with the fisheries exhibit.

Messrs. H. K. & F. B. Thurber & Co., of New York City, have undertaken to prepare for the Museum, without charge, a full exhibition of the food-substances handled in the grocery trade of the United States, which will form an excellent nucleus for this department. There have been received from the various manufactories of canned fishery products sample cans showing all the brands of canned fish put up in the United States during the census year—an important addition to the fishery collection.

It would be premature to attempt to state the extent and nature of the collections in this department. Through the exertions of Mr. Thomas Donaldson, a large number of the most important of the exhibits which were retained at the close of the Philadelphia Exhibition in the so-called Permanent Exhibition of Philadelphia have been given to the National Museum and are now stored in Philadelphia, there to be retained until the Museum is ready for their reception. An enumeration of these articles will be more appropriate in the report for the year 1882.

*Aid of Manufacturing and Commercial Firms.*—Important contributions have been promised by several manufacturing and commercial houses, prominent among which are a full exhibition of paints, varnishes, and pigments, by Messrs. F. W. Devoe & Co., of New York; of chemical products, by Powers, Weightman & Co., of Philadelphia; of perfumes and essential oils, by Young, Ladd & Coffin, of New York City; of the appliances and operations of dentistry, by the S. S. White Manufacturing Company, of Philadelphia, and others of less extent but of equal interest.

*Accessions of the year.*—Among the important contributions received during the year may be mentioned a large series of cotton fabrics, illustrating the condition of that branch of the textile industry of the United States during the census year, sent by the various mills at the request of Mr. Edward Atkinson, special agent of the Tenth Census; a collection of the ornamental woods of Japan, a hundred in number, consisting of



panels of polished wood, upon which are painted accurate delineations of the leaves, flower, and fruit of the trees from which they are derived, and framed in sections of the bark of the same tree, given by the University of Tokio; a collection illustrating fully the ice industry, given by the Knickerbocker Ice Company; a whale-boat with all its apparatus, given by J. H. Bartlett & Sons, of New Bedford, Mass.; a collection of 30 working models of schooners, illustrating the history of the fishing schooner of New England from the beginning of the present century, obtained by Mr. A. Howard Clark from the ship-builders of Cape Ann, Mass.; an exhibit illustrating the process of making kid gloves, showing each stage from the natural skin to the completed glove, the gift of Eugene Krebs, Regensburg, Germany; a series of samples of the native cottons of Japan, from the Japanese Government; an illustration of the process of overlaying and wood-cut printing, given by Mr. Theodore L. De Vinne, of New York; and a collective exhibit of brushes, showing all the applications of hair and bristles manufactured, from Miles Bros. & Co., of New York.

#### ARCHÆOLOGY: CHARLES RAU.

The installation of the collections in the archæological department, under the direction of Dr. Charles Rau, is further advanced than in any other department of the Museum. The bulk of specimens is now so great that there is not room for their proper exhibition in the apartment assigned to them, and the removal to the new building of the ethnographic and industrial materials now exhibited in the archæological hall will afford opportunity for a much better presentation of the relics of prehistoric man. Dr. Rau reports 1,432 entries in his record books during the last half of the year,\* and all important objects have been mounted and placed in the exhibition cases. It is estimated that there are now 20,536 specimens mounted, labeled, and arranged in the exhibition series.

Among the most important accessions to this department are twelve boxes, containing 195 specimens, obtained by Hon. J. G. Henderson in the mounds near Naples, Ill.; a fine series of 130 specimens of Danish stone implements, the gift of the Royal Museum of Copenhagen, Denmark; 52 specimens, the result of mound exploration in Sauk County, Wisconsin, by Mr. Stephen Bowers; 161 specimens of stone implements from Carroll County, Tennessee, by Mr. James M. Null; 99 specimens of Indian remains and implements, collected by Mr. S. T. Walker on the southern shore of Choctawhatchee Bay, Florida; 154 specimens of implements from Mrs. S. S. Haldeman, Pennsylvania; collections made by Dr. Edw. Palmer in Tennessee and adjoining States, and two drilled

\*The archæological specimens prior to July 1, 1881, were entered in the general ethnological catalogues, and the entries for the entire year are included in the 5,841 entries given for ethnology in general.

ceremonial objects of great value, acquired by purchase from Mr. D. W. Harris, of Louisiana.

#### ETHNOGRAPHY.

Dr. Edward Foreman has been constantly employed since June 1 in cataloguing the ethnographic material. The most important accession of the year consists of forty-four boxes obtained by Col. James Stevenson from the Pueblo Indians of the Southwest, the contents of which have been placed on exhibition in temporary cases in the northeast range of the new building.

Among other important collections are those made by Messrs. Lucien M. Turner and E. W. Nelson, Signal-Service observers in Alaska; a considerable collection of objects obtained by Commander L. A. Beardslee, U. S. N., the most of which were devices made by the Shamans of the Northwest coast, including a series of curiously carved and painted rattles, a wand similarly decorated, a wooden spoon, &c., all of them bearing superstitious figures and employed by the medicine men in the use of witchcraft and in expelling disease; a few Indian implements obtained by O. J. Hering from Surinam, and a collection of 34 masks from Japan, used by the actors in the mediæval lyric drama of that country, known as "No," and obtained through the First Manufacturing and Trading Company of Tokio.

During the year, General Horace Capron deposited a valuable collection of Japanese materials, obtained by him while in the service of that government.

#### MAMMALS: FREDERICK W. TRUE.

In the department of mammals there have been fifty-five accession lots and 97 entries in the catalogue. Little has been done with the exhibition series during the year, an early removal of the collections to the new building being contemplated. Cases for their reception are now in progress of construction. Mr. True, acting curator of the department, reports the following census of mounted mammals:

Monkeys and lemurs.....	24	Bats .....	8
Cats .....	20	Moles .....	17
Dogs and hyenas.....	31	Rodents .....	300
Weasels, otters, &c.....	125	Edentates .....	30
Bears, raccoons, &c.....	9	Marsupials and monotremes..	56
Pinnipeds .....	30	Casts: Monkeys.....	2
Oxen and sheep .....	14	Seals .....	2
Deer .....	9	Elk.....	1
Hogs.....	4	Porpoises .....	10
Rhinoceros .....	1		
Tapirs.....	2	Total.....	695

Among the most important additions have been a collection of skins of Arctic mammals, sent by Mr. R. McFarlane, of Hudson's Bay Company, from Athabasca; a collection of mammals from Surinam, sent by Mr. C. J. Hering, of Paramaribo; skins of antelope and deer, sent by Mr. Charles Ruby, of the United States Army, at Fort Laramie, Wyo.; skins of polar bear, white whale, and three species of seal, including one male and two young of the very rare saddle-back seal, *Histiophoca equestris*, brought by E. W. Nelson, Signal-Service observer at Saint Michael's, Alaska; a specimen of manatee, in the flesh, from the Amazon River, by E. G. Blackford, of New York, and a mounted skeleton of the celebrated race-horse Henry Clay, the progenitor of the American race of trotting horses, given by Hon. Erastus Corning, of Albany, and Mr. Henry O. Jewett, of Buffalo. Mr. P. T. Barnum has sent a specimen in the flesh of a leopard, which has been cast; and, in response to special request for specimens of thorough-bred dogs, to be used in forming a collection of casts of the races of domestic dogs, Dr. T. Berwick Legaré, of Camden, S. C., has given a pointer dog of the best blood; and Miss Anna W. Kelly, of Havre de Grace, Md., an Italian greyhound. From the United States Fish Commission and its correspondents have been obtained seven specimens of porpoises in the flesh, all of which have been cast, and which afford extremely valuable material for settling certain undecided questions concerning the cetacea of the Atlantic. The progress of the work upon the cast of the fin-back whale has been alluded to in connection with the work of the preparators.

#### BIRDS: ROBERT RIDGWAY.

In the department of birds there have been seventy-four accession lots. Under the direction of Mr. Robert Ridgway there has been much activity in this department in reorganizing the exhibition series of specimens and in eliminating duplicates from the storage series. There have been 4,345 entries in the catalogue. The removal of the mammals and skeletons to the new building will give an opportunity for a much more satisfactory exhibition of the ornithological collections.

The most important addition has been Mr. Ridgway's private collection of American birds, containing 2,302 specimens of 778 species, especially important because the specimens have been selected in the field to illustrate variations of color and form due to age, sex, and geographical location.

In addition to numerous small collections, others of special interest have been received of the birds of Mexico and Yucatan, from A. Boucard, of Paris; of Surinam, from C. J. Hering, of Paramaribo; of Grenada, from J. G. Wells, of Saint Andrews; of Guatemala, from L. Guesde; of Dominica, from Dr. H. A. Nichols; of Costa Rica, from J. C. Zeledon; of Japan, from Dr. F. C. Dale, U. S. N.; of Florida, from Messrs. J. Bell and S. T. Walker; of Wyoming, from Charles Ruby; of Indiana, from Mr. Ridgway; and of Illinois, from Mr. L. M. Turner.

Mr. Ridgway gives the following census of the bird collection :

Reserve series :

Mounted specimens .....	7, 000
Skins .....	40, 000
Total reserve .....	47, 000
Duplicates .....	8, 000
Total .....	55, 000

REPTILES AND BATRACHIANS: HENRY C. YARROW.

The department of herpetology, under the direction of Dr. H. C. Yarrow, has received much attention, and the work of separating the reserve series, for exhibition and study, from the duplicates has been nearly completed. The collection has been put in excellent order, in fresh alcohol, and provided throughout with tags of block-tin. The large collections of exotic and domestic reptiles which have for many years been under the custody of Prof. E. D. Cope, of Philadelphia, have been reclaimed and properly distributed. There have been, during the year, seventy-five accession lots received, and 1,974 entries upon the catalogues. Messrs. Walker, Bell, and Wittfield have collected extensively in Florida; Mr. Ridgway, in Indiana; Mr. S. W. Marnark, in Texas; and Mr. Henry L. Barker, in South Carolina. The exotic reptiles have been received from C. J. Hering; Professor Duges, of Mexico; Mr. L. Guesde, of Guadalupe; Dr. Wilford Nelson, British consul at Panama; Prof. Felipe Poey, of Havanna, Cuba; and Mr. Figielmesy, United States consul at Demerara. A considerable percentage of the reptiles has been received alive, and there has been opportunity to add largely to the collection of casts. The collection of turtles has been overhauled, and has been arranged by Messrs. Frederick W. True and Newton P. Scudder.

A census of the collections of reptiles gives the following result :

Number of species North America reptiles represented* .....	361
Number of specimens (lots) in reserve .....	3, 340
Number of exotic specimens (lots) .....	1, 765
Number of species added to reserve in 1881 .....	67
Number of specimens added to reserve in 1881 .....	239
Number of lots overhauled in 1881 .....	3, 653
Number of living specimens received .....	127
Number of living specimens on hand .....	35

The collection of casts numbers 82, 61 being of snakes, 11 of lizards, 3 of crocodiles, and 7 of batrachians.

\* Forty-three species lacking.

Many of the turtles have been sent to the carp ponds of the Fish Commission, where a large proportion of all species of American testudines may now be seen living. The reserve collection of turtles, according to Messrs. F. W. True and N. P. Scudder, who have had it in charge, now includes 568 specimens, of which 490 are in alcohol, 38 are casts, and 40 are skeletons.

#### FISHES: TARLETON H. BEAN.

In the department of ichthyology, under the direction of Dr. T. H. Bean, there has been much activity, but, owing to the immense bulk of the collections, the limited storage-space, and the entire absence of accommodation for the exhibition of the reserve series, the work has been much retarded. The fitting up of the west range of the Smithsonian building for the reception of alcoholic vertebrates—a work now nearly completed—will enable the curator of this department to revolutionize its arrangement during the coming year. It is impossible at present to make any estimate whatever of the extent of these collections. There have been during the year 125 accession lots and 2,639 entries on the catalogues. The most important additions to the collections resulted from the labor of the United States Fish Commission, whose recent explorations in the deeper waters along the coast have resulted in the discovery of numerous important forms of deep-sea fish. The collections made by Prof. D. S. Jordan on the coast of California, and by Dr. T. H. Bean in Alaska, are also very extensive and full of interest. The former were overhauled by Prof. D. S. Jordan and his assistant, Mr. Charles L. McKay, during a visit to the Museum in February; and, after the reserve series had been taken out, 70 sets of duplicates, containing in all about 15,000 specimens, were made up. These have since been distributed to the principal museums of the world, giving to the National Museum large credits upon which to draw in future for duplicate natural-history material in the possession of those establishments.

Important collections were also received from Mr. O. H. Gilbert, who during the winter of 1881 made extensive explorations on the Pacific coast of Central America and the Isthmus of Panama.

Important lots have also been received from Mr. James G. Swan, collected by him in the vicinity of Puget Sound; from Lieut. H. E. Nichols, in Alaska; from Mr. C. C. Leslie, in Charleston, S. C.; from Capt. Charles Bendire, U. S. A., in Washington Territory; from Josiah Skinner, in the vicinity of Wetumpka, Ala; from Vinal N. Edwards, Wood's Holl, Mass.; from Col. Marshall McDonald, in the Chesapeake Bay; from Mr. E. G. Blackford, of Fulton Market, New York City; from Prof. S. A. Forbes, in the waters of Illinois; from Miss Rosa Smith, in San Diego, Cal.; from Andrea Larco, of Santa Barbara; from Dr. J. W. Vellie, of the Chicago Academy of Sciences; from S. T. Walker and Silas Stearns, in Florida; from Livingston Stone, in California; from Walter



Hayden, at Moose Factory, Hudson's Bay territory; and from Dr. O. P. Hay, in the Mississippi River. Exotic fishes have been received from F. Busse, of Giestemünde, Germany; from Dr. H. A. Nichols, of Dominica; from the Public Museum of Kingston, Jamaica; from the Auckland Museum of New Zealand; from Prof. Alfred Dugès, of Guanajuato, Mexico; and from Frederick M. Wallem, of Bergen. Charles Scribner's Sons, of New York, have presented a copy of the sumptuous work published by them on the "Game Fishes of North America:"—the text by G. Brown Goode, the plates by J. A. Kilbourne.

#### INSECTS: CHARLES V. RILEY.

The department of entomology is one which has, for excellent reasons, been very little cultivated in the National Museum, although in previous years the Smithsonian published many extensive works on insects, and paid much attention to gathering material for investigation.

The subject of entomology is divided by students into so many branches, each of which is occupied by a small number of specialists, and it being deemed of first importance to have the materials which are collected carefully studied and reported upon, the collections, as received, have been distributed in lots to the eight or ten entomologists who have been serving as collaborators of the Museum, and the material not thus disposed of has been turned over to the entomologists of the Department of Agriculture. The necessity of a department of systematic and economic entomology has, however, been always recognized, and on the occasion of the present reorganization steps have been taken to establish such a department. Prof. C. V. Riley, the entomologist of the Department of Agriculture, has been appointed honorary curator, and has deposited his own private collection of insects, with the idea of using it as a nucleus for the development of a collection fitting the dignity of a national museum.

The collection deposited by Professor Riley, as stated in the circular, comprises some 30,000 species and upward of 150,000 specimens of all orders, and is contained in some 300 double-folding boxes, in large book form, and in two cabinets containing 80 glass drawers, the specimens being all in admirable condition and classified, so far as determined. The collection is especially valuable for the large amount of material it contains, representing and illustrating the life-habits of insects and everything relating to their transformation and economy.

In addition to the collection proper, Professor Riley has also furnished a large amount of microscopic material mounted on slides, and illustrative of more minute forms of insect life and their structure, together with much paraphernalia, such as drying and relaxing boxes, spreading-boards, collecting-materials, &c., which will prove most useful in the work of the department. Finally, he has also added that portion of his pamphlet-case library relating to the subject of entomology, and consisting of 134 cases and upward of 1,000 pamphlets.

Three large walnut cases, containing entomological material, both dry and in alcohol, have been transferred, with the consent of Commissioner Loring, from the Department of Agriculture. This material represents the accumulation of many years from different government exploring expeditions, though most of it has passed through the hands of specialists and is not in very good condition.

Specialists in entomology will be encouraged to deposit their types by the promise of painstaking custody, and particular attention will be paid in the future to the development of this department. There have been received during the year fifty-three accession lots, the most interesting of which, perhaps, were collections of butterflies from Africa and Brazil, presented by Paymaster Albert W. Bacon, U. S. N., and a series of plaster casts of the dwellings of Texas ants, obtained from the Academy of Natural Sciences, Philadelphia.

#### CONCHOLOGY: WILLIAM H. DALL.

The department of conchology, under the care of Mr. W. H. Dall, honorary curator, has been in a quiescent state during the year, owing to the fact that the officer in charge has been occupied in other duties. The removal of the invertebrate fossils to the other building will, by affording more room in the conchological laboratory, give better opportunities for work in the future. Eighteen accession lots have been received in the Museum, chief among which are a collection from the Pacific coast by Mr. Henry Hemphill, of San Diego, Cal.; and a collection from Italy, received from Rev. Eugene Vetromile, of Machias, Me. Extensive additions have been made to this department in the course of the dredging operations of the United States Fish Commission. This material, with that of previous years, is still in the hands of Prof. A. E. Verrill, at New Haven, where it is being worked up under his direction.

Among other important collections, which will be made available to students as soon as cases can be provided, is that recently deposited by Mr. W. G. Binney, containing the types of his voluminous writings upon the land and fresh-water shells of North America; and the collection of North American *Unionidæ*, labeled for the Museum by Dr. James Lewis, of Mohawk, N. Y.

#### MARINE INVERTEBRATES: RICHARD RATHBUN.

The department of marine invertebrates, under the direction of Mr. Richard Rathbun, has been enriched by thirty-one accession lots. As in the case of the conchological department, the principal additions have been made by the United States Fish Commission, which have not yet been forwarded from New Haven. There has been great activity in this department, as is indicated by the report of its curator.

Three thousand three hundred and thirty-four entries have been made

in the record books; 1,358 radiates; 1,164 crustaceans; 700 sponges and protazoa; and 112 mollusks.

All the materials in storage have been examined and have received what care was necessary. Much work has been accomplished in the way of duplicate material for distribution, it being estimated that over a million specimens, representing one hundred and fifty species, are now ready to be distributed in this manner.

"One of the most important achievements made in this department in 1881," reports the curator, "has been the proper mounting for museum display of nearly all the reserve specimens of corals and sponges now possessed by the Museum." This work has been performed by Mr. E. H. Hawley in the most perfect manner, and he has also just finished mounting a series of the larger and more prominent New England echinoderms; the larger share of the stony corals mounted and some of the Gorgonian corals are types collected by the United States Exploring Expedition, labeled by Prof. J. D. Dana, and some recently examined and relabeled by Prof. A. E. Verrill.

The coral collection is one of great value and beauty, and represents many faunal regions. All of the species of corals known from the fishing-banks of eastern North America are represented in it.

The mounted collection of sponges contains specimens of all the species and of most of the varieties of commercial sponges from Florida, the Bahamas, and the Mediterranean, labeled by Prof. A. Hyatt of the Boston Society of Natural History. In addition are many specimens collected by the United States Exploring Expedition, and from other sources.

The total number of specimens mounted is 1,031; 700 of which are corals; 225, sponges; and 106, echinoderms.

The corals which have been thus mounted are believed to be more artistically and tastefully exhibited than any similar collection in any other museum in the world.

The west hall of the Smithsonian Building is now being fitted up for the reception of this collection; the minerals and ceramic specimens, hitherto there displayed, being in process of removal to the new building. The special collection of the cephalopod crustaceans made by Mr. Rathbun, as material for a special investigation now in progress in his laboratory, is one of the finest in the world, filling over seven hundred bottles. Among the most interesting accessions, in addition to those gathered by the Fish Commission, are a number of small lots obtained by the Gloucester fishermen on the off-shore banks, a fine collection of invertebrates from the vicinity of Cherrystone, Virginia, gathered by Col. Marshall McDonald of the Fish Commission; a choice suit of corals from Hayti, the gift of Prof. J. M. Langston, consul-general, at Port au Prince; collections of marine invertebrates gathered by Messrs. Nelson and Turner, and from Japan by Dr. F. C. Dale, U. S. N., and Mr. P. L. Jouy, attached to the U. S. steamer Palos.

There have been fifty-seven accessions of paleontological specimens. Except in the department of invertebrate paleontology, under the direction of Dr. C. A. White, curator, there has been little attention paid during the year to work upon the collections of fossils.

#### FOSSIL INVERTEBRATES: C. A. WHITE.

The collections in invertebrate paleontology have received considerable attention from Dr. White, who has, however, been absent for a great part of the year, occupied in work for the Geological Survey and as a member of the artesian wells commission, under the direction of the Commissioner of Agriculture. Material progress has, however, been made in the final arrangement of the tertiary and cretaceous fossils, valuable from having been so thoroughly reported upon by the late Prof. F. B. Meek. Among the most important accessions to this collection have been the first series of duplicates from the Hall collection of fossils, the gift of the American Museum of Natural History, of New York City, a collection of cretaceous and Laramie fossils, gathered in Colorado by Dr. White, and a large collection of European tertiary and cretaceous fossils from M. J. J. M. De Morgan, of Paris.

#### FOSSIL BOTANY: LESTER F. WARD.

Prof. L. F. Ward, fossil botanist of the Geological Survey, has been appointed honorary curator of the department of fossil botany; but, at the beginning of the present calendar year, he had not entered upon active duties. The extensive collection of fossil-plants gathered in past years by the government exploring expeditions and geological surveys, and which has for many years been in the custody of Prof. Leo Lesquereux, of Columbus, Ohio, one of the finest collections of fossil-plants in the world, having been re-arranged and labeled by Professor Lesquereux, has been placed in the final custody of the museum. Cases have been prepared for its reception, and during the present year it will be arranged for the use of students. The collection of fossil vertebrates, filling hundreds of boxes, is still in the storage-rooms. No steps have yet been taken to provide for their rearrangement.

#### PLANTS: DEPARTMENT OF AGRICULTURE.

In accordance with an arrangement made many years ago with the Department of Agriculture, all botanical specimens received by the National Museum are placed in the custody of the botanist of that establishment, and the very extensive herbaria of the Museum are on deposit in the Agricultural Buildings, under the charge of Dr. Geo. A. Vasey.

Fourteen accession lots of plants have been received during the year.

A portion of these are living water plants, and have been assigned to the superintendent of the government carp-ponds, under whose charge the Fish Commission has developed an extensive plantation of water-lilies and other interesting aquatic species.

**MINERALOGY AND ECONOMIC GEOLOGY: GEORGE W. HAWES.**

In the department of mineralogy, under the direction of Dr. G. W. Hawes, there has been great activity during the year. The mineralogical and metallurgical materials, collected in all parts of the country for the Centennial Exhibition, and presented by foreign governments at its close, and which for five years past have occupied the two lower stories of the armory building, have all been unpacked and assorted, and the greater portion of them removed to the new building. Many of the most bulky and interesting blocks of minerals and ores have been placed on exhibition on a concrete pavement outside of and along the west main hall of the new building. Dr. Hawes, in connection with an investigation upon the building-stones of the United States, which he is carrying on in behalf of the Tenth Census, has gathered specimens of stone from every quarry in the United States; and a force of fifteen men, in part detailed from the Census Office, has been occupied all the year in preparing them for study and exhibition. The blocks, which are, for the most part, received by mail in a rough condition, have been dressed and polished in four-inch cubes. These cubes, when finished, show upon different sides the appearance of the stone when polished, ax-hammered, bush-hammered, rough-faced, drafted, and rough.

Up to the 1st of January, 1881, there have been forwarded by special agents of the census, or by other persons upon their solicitations, 3,030 specimens of building-stones, representing nearly every quarry of importance in the United States. Of this number 1,277 have been dressed in the manner just referred to. The Museum had already in its possession 535 dressed specimens, many of them in blocks a foot square, or larger, and beautifully polished, showing the products of many of the principal American quarries, and those of several foreign countries.

Numerous analyses of building-stones by the chemical and specific gravity methods have been made by Messrs. F. P. Dewey and F. W. Taylor.

Since the 1st of June, Mr. Geo. P. Merrill has prepared 1,550 microscopic slides of building-stones, to be used in connection with the investigation.

In addition to the building-stones received, there have also been fifty-seven accession lots, among the most important of which are a magnificent collection of stalactites and stalagmites from the Luray Caverns, the gift of the Shenandoah Valley Railroad Company, and an extensive series of minerals from the Yellowstone National Park, including the top of a geyser with seventeen openings, obtained by Col. P. W. Norris, superintendent of the park.

APPENDIX A.—LIST OF OFFICERS, JANUARY 1, 1882.\*

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SPENCER F. BAIRD.....	Secretary of the Smithsonian Institution and Director.
G. BROWN GOODE.....	Assistant Director; Curator, Dep't of Art and Industry.
WILLIAM H. DALL.....	Honorary Curator, Department of Conchology.
ROBERT RIDGWAY.....	Curator, Department of Ornithology.
CHARLES RAU.....	Curator, Department of Archaeology.
TARLETON H. BEAN.....	Curator, Dep't Ichthyology, and Editor of Proceedings.
HENRY C. YARROW.....	Honorary Curator, Department of Herpetology.
CHARLES A. WHITE.....	Curator, Department of Invertebrate Paleontology.
GEORGE W. HAWES.....	Curator, Department of Geology.
JAMES M. FLINT.....	Honorary Curator, Department of Materia Medica.
RICHARD RATHBUN.....	Assistant Curator, in charge Dep't of Marine Invertebrates.
EDWARD FOREMAN.....	Assistant, Department of Ethnography.
FREDERICK W. TRUE.....	Librarian; acting Curator, Department of Mammals.
FREDERICK W. TAYLOR..	Chemist.
GEORGE P. MERRILL.....	Aid, Department of Mineralogy.
WILLIAM S. YEATES.....	Aid, Department of Mineralogy.

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APPENDIX B.—BIBLIOGRAPHY OF MUSEUM WORK FOR 1881.

I.—PAPERS BY OFFICERS OF THE MUSEUM.

- BEAN, TARLETON H. Descriptions of new species of fishes (*Uranidea marginata*, *Potamocottus Bendirei*) and of *Myctophum crenulare* J. & G.  
(Proc. U. S. Nat. Mus., 1881, iv, pp. 26-29.)
- Notes on some fishes from Hudson's Bay.  
(Proc. U. S. Nat. Mus., iv, pp. 127-129.)
- Descriptions of new fishes from Alaska and Siberia.  
(Proc. U. S. Nat. Mus., iv, pp. 144-159.)
- Identifications of McCloud River, California, fishes, referred to in a paper based on a letter of J. B. Campbell.  
(Bull. U. S. Fish Com., 1881, i, p. 46.)
- Directions for collecting and preserving fish.  
(Proc. U. S. Nat. Mus., iv, pp. 235-238.)
- A preliminary catalogue of the fishes of Alaska and adjacent waters.  
(Proc. U. S. Nat. Mus., iv, pp. 239-272.)
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\* The names in each grade are arranged in the order of seniority.

BEAN, TABLETON H. Movements of young alewives (*Pomolobus* sp.) in Colorado River, Texas.

(Bull. U. S. F. C., 1881, i, pp. 69, 70.)

— Notes on a shipment by the United States Fish Commission of California salmon (*Oncorhynchus chouicha*) to Tanner's Creek, Indiana, in 1876.

(Bull. U. S. F. C., i, pp. 204, 205.)

— Account of a shipment by the United States Fish Commission of California salmon-fry (*Oncorhynchus chouicha*) to Southern Louisiana, with a note on some collections made at Tickfaw.

(Bull. U. S. F. C., i, pp. 205, 206.)

— A contribution to the biography of the commercial cod of Alaska. (*Forest and Stream*, April 28, 1881, pp. 250-252; also in *Trans. Amer. Fish Cult. Association*, 1881, pp. 16-34.)

— List of deep-water fishes, etc. See under VERRILL, Notice of the remarkable Marine Fauna of New England.

(*Am. Jour. Sci.* Oct., 1881, vol. xxii, pp. 295-297.)

— See also under GOODE and BEAN.

DALL, WILLIAM H. The Chukchis and their neighbors in the north-eastern extremity of Siberia.

(*Proc. Royal Geogr. Soc. London*, iii, pp. 568-570.)

— Hydrologie des Bering-meeres-und der benachbarten Gewässer. (*Petermann's Geogr., Mittheilungen*, 1881, pp. 361-380.)

— Table of currents in Northern Pacific and map of Bering Strait and vicinity.

— Hydrologie des Bering-Meeress und der benachbarten Gewässer (*Petermann's Geogr., Mittheilungen*, 1881, pp. 443-448.)

— American work in the department of recent Mollusca during the year 1880.

(*Amer. Naturalist*, September, 1881, xv, pp. 704-718. Separate; without cover or title page.)

— On the so-called Chukchi and Namollo people of Eastern Siberia.

(*Amer. Naturalist*, November, 1881, xv, pp. 857-868. Separate; not repaged without cover.)

— Intelligence in a snail.

(*Amer. Naturalist*, December, 1881, xv, pp. 976-977. Separate; without cover.)

— Some recent observations on Molluscs.

(*Bull. Phil. Soc., Washington*, 1880, vol. iii, pp. 75, 76.)

— Ex. report, Coast Survey.

(*Amer. Jour. Sci.* February, 1881, xxi, pp. 104-111.) Separate, with following title:

From the *American Journal of Science*, vol. xxi, February, 1881.

— Notes on Alaska and the vicinity of Bering Strait. By W. H. Dall, assistant in charge of schooner Yukon, employed on the coast of Alaska; with a map. Extract from a report to O. P. Patterson, Superintendent Coast and Geodetic Survey.

(8vo., pp. 104-111.)

HAWES, GEORGE W.—The Albany granite, New Hampshire, and its contact phenomena.

(Amer. Journ. Sci. and Arts, Jan., 1881, xxi, p. 21.)

— On liquid carbon dioxide in smoky quartz.

(Amer. Journ. Sci. and Arts, March, 1882, xxi, pp. 203-9, 13 figs.)

— On the mineralogical composition of the normal mesozoic diabase upon the Atlantic border.

(Proc. U. S. Nat. Mus., iv, pp. 129-137.)

— On the determination of feldspar in thin sections of rocks.

(Proc. U. S. N. M., iv, pp. 134-6.)

JOUY, PIERRE LOUIS.—Description of a new species of *Squalius* (*Squalus aliciae*), from Utah Lake.

(Proc. U. S. N. M., iv, p. 19.)

See also below, under D. S. JORDAN.

RAU, CHARLES.—Aboriginal stone drilling.

(Amer. Naturalist, July, 1881, xv, pp. 536-542. Illustrated.)

Relating to the method employed in drilling stone by the American aborigines.

— Department of the Interior. U. S. Geographical and Geological Survey of the Rocky Mountain Region, J. W. Powell in charge. Observations on Cup-shaped and other Lapidarian Sculptures in the Old World and in America, by Charles Rau. [From "Contributions to North American Ethnology," vol. v.] Washington: Government Printing Office. 1881. 4to, pp. 102, 61 illustrations on 35 plates.

RIDGWAY, ROBERT.—Nomenclature of North American Birds, chiefly contained in the United States National Museum.

(Bull. U. S. Nat. Mus. No. 21. Washington: Government Printing Office, 1881. 8vo., pp. 94.)

The great need of a new catalogue of North American birds, which prompted the publication of this list, is explained in the opening paragraph of the introduction, as follows:

Since the publication, in 1859, of the last Smithsonian catalogue of North American birds, so many important changes have been made in the nomenclature of the species, and so numerous have been the additions to the fauna, that the wants of ornithologists require a new list which shall bring the subject up to date.

— Swainson's Warbler (*Helonæ swainsoni*) in Texas.

(Bull. Nutt. Orn. Club, Jan., 1881, vol. vi, p. 54.)

The range of this species was previously confined to Northern Florida and the adjacent portions of Georgia, Alabama, and South Carolina, with somewhat doubtful records in Cuba and Southwestern Indiana. Its occurrence in Navarro County, Texas, was communicated to the author by Mr. J. Douglas Ogilby, a correspondent of the National Museum.

— On a Duck new to the North American Fauna.

(Proc. U. S. N. M., 1881, iv, pp. 22-24.)

Based upon a specimen of *Fuligula rustina* (Pall.) (No. 61957) in the U. S. National Museum, obtained in Fulton Market, New York, and presumably shot on Long Island Sound.



RIDGWAY, ROBERT.—On *Amazilia yucatanensis* (Cabot) and *A. cerviniventris*, Gould.

(Proc. U. S. Nat. Mus., 1881, iv, pp. 25, 26.)

A recent authority on the Humming-birds having united the above-named species, and the editors of "The Ibis" having suggested that an actual comparison of the two "would be satisfactory," the type specimen of the former was borrowed for the purpose from its collector and owner, Dr. Samuel Cabot, jr., of Boston. From this actual comparison of the two, the author was enabled to establish their distinctness from each another.

— A Hawk new to the United States.

(*Forest and Stream*, Apr. 14, 1881, vol. xvi, p. 206.)

Announcement of the capture of *Buteo fuliginosus*, Sc., in Florida.

— Southern Range of the Raven on the Atlantic Coast of the United States.

(Bull. Nutt. Orn. Club, April, 1881, vi, p. 118.)

The southern limit of the Raven along the Atlantic sea-board, as previously recorded, was the coast of New Jersey; but the known range of the species was considerably extended by the observations of the author, who, while engaged in an exploration under the auspices of the National Museum, found it to be not uncommon on the islands near Cape Charles, Virginia.

— An unaccountable migration of the Red-headed Woodpecker.

(Bull. Nutt. Orn. Club, April, 1881, vi, pp. 120-122.)

In the autumn of 1879, this species (*Melanerpes erythrocephalus*), which is ordinarily, and especially in winter, the most abundant of the Woodpeckers in Southern Illinois, made a general migration, and did not reappear until the following spring. The cause of this disappearance was not apparent, since every other species of the family (six in number) were normally abundant.

— The Caspian Tern in California.

(Bull. Nutt. Orn. Club, April, 1881, vi, 124.)

A notice of two specimens of *Sterna* (or *Sylochelidon*) *caspia* from California, in the collection of the National Museum, being the first record of this species from the Pacific coast of America.

— A Revised Catalogue of the Birds Ascertained to Occur in Illinois.

(Bull. Illinois State Laboratory of Nat. Hist., May, 1881, No. 4, pp. 163-208.)

This catalogue (of 341 species) is based very largely upon collections made by the author at Mt. Carmel and in the vicinity of Olney, Illinois, and deposited in the U. S. National Museum.

— A critical Review of the Genus *Centurus*, Swainson.

(Proc. U. S. N. M., iv, pp. 93-119.)

— On a Tropical American Hawk to be added to the North American Fauna:

(Bull. Nutt. Orn. Club, Oct. 1881, vi, pp. 207-214.)

Based upon two specimens, in the collection of the National Museum, of *Buteo brachyurus* Vieill. from Palatka, Florida (G. A. Bordman), and *B. fuliginosus* Sc. from Oyster Bay, Florida (W. S. Crawford).

RIDGWAY, R.—List of Species of Middle and South American Birds not contained in the United States National Museum. [Corrected to July, 1881.]

(Proc. U. S. Nat. Mus., vol. iv, pp. 165-203.)

A list of all the known species of tropical American birds not represented in the national collection, with authorities and habitats, prepared for distribution to public museums and collectors.

— List of Special Desiderata among North American Birds.

(Proc. U. S. Nat. Mus., vol. iv, pp. 207-223.)

Prepared for the use of correspondents of the National Museum and those wishing to make exchanges. The list includes all deficiencies in the way of desirable species, special plumages, &c., wanted to render the national collection more complete.

RILEY, CHARLES V.—\* Silk-culture in the United States. Condensed account of the silkworm and how to inaugurate a new source of wealth.

(Western Farmers' Almanac, 1881, pp. 35-39, Fig. 14.)

— Larval habits of bee-flies (*Bombyliidæ*).

(Amer. Naturalist, Feb., 1881, xv, pp. 143-145, Fig. 1-3.)

*Systoechus oreas* parasitic on *Caloptenus apretus*, *Bombylius major* (of Europe) on *Andrena labialis*. Larvæ and pupæ of the two species compared; larva, pupa, and imago of *S. oreas* figured.

— Safe Remedies for Cabbage Worms and Potato Beetles. Experiments with Pyrethrum.

(Amer. Naturalist, Feb. 1881, xv, pp. 145-147.)

Details of numerous experiments, made under direction of the author, by A. J. Cook and W. R. Hubbert, proving the efficacy of pyrethrum powder in the destruction of those and other insects.

— The food of fishes.

(Amer. Naturalist, Feb. 1881, v. xv, pp. 147-148.)

Notice of S. A. Forbes's "The food of fishes," and "On the food of young fishes."

— Insect enemies of the rice plant.

(Amer. Naturalist, Feb. 1881, xv, pp. 148-149.)

Identifies *Chalepus trachypygus* feeding on roots of the rice plant, and conjectures that other mentioned enemies of rice may be *Spalacopsis suffusa* and *Centrinus concinnus*. Rice plant in India injured by *Cecidomyia oryza*.

— The "Yellow-Fever Fly."

(Amer. Naturalist, Feb. 1881, xv, p. 150.)

Rev. of H. A. Hagen's The "Yellow-Fever Fly" (Psyche, Sep., 1880,) records occurrence of swarms of *Sciara* in the imago state.

— The United States Entomological Commission [C. V. Riley, A. S. Packard, jr., Cyrus Thomas], (Department of the Interior). Second report for the year 1878 and 1879 relating to the Rocky Mountain locust and the western cricket, and treating of the best means of subduing the locust in its permanent breeding grounds, with a view of preventing its migrations into the more fertile portions of the trans-Mississippi country, in pursuance of appropriations made by Congress for this purpose;—with maps and illustrations. Wash.,

\* This list has been kindly prepared by Mr. B. Pickman Mann.

RILEY, CHARLES V.—Continued.

1880 [March, 1881], 18 + 322 + 80, p. 17 pl., each plate with one leaf explanation, map 1, in 6 pts., map 2-4, 9 fig.

Extract from chap. 13, by Riley, entitled "Larval habits of bee-flies." (Amer. Naturalist, June, 1881, v. xv, pp. 438-447, pl. 6.) Germ. tr. of part of p. 260, entitled "*Epicauta vittata* aus Eiern zu erziehen". (Entom. Nachr., Aug. 1881.)

Separate of chap. 13, author's ed., by Riley, with half t. p. cover and half t. p., entitled "The Rocky Mountain locust." Further facts about the natural enemies of locusts [Wash.], 1880. + p. 259-271, pl. 16, with one leaf expl. of pl.

Separate of chap. 14, author's ed., by Riley, with half t. p. cover and half t. p., entitled "The Rocky Mountain locust. Permanent courses for the government to adopt to lessen or avert locust injury." [Wash.] 1880. + p. 271-322; map 1, in 6 parts.

— Notes on the grape Phylloxera and on laws to prevent its introduction.

(Amer. Naturalist, March, 1881, xv, pp. 238-241.)

Summary of life history of *Phylloxera vastatrix*. Proper precautions to be adopted against the introduction of the pest into uninfected countries.

— Hibernation of the Cotton Worm moth; ease with which mistakes are made.

(Amer. Naturalist, March, 1881, xv, pp. 244-245, Figs. 1-3.)

Imago of *Leucania unipuncta* mistaken for that of *Aletia argillacea*, in Texas; distinctive characteristics of the two species; figures imagos of both species and ovipositor of the former.

— General Index and supplement to the nine Reports on the insects of Missouri.

(U. S. Entomological Commission, Bulletin No. 6, Wash., 24 March, 1881, t. p. cover, pp. 1-178.)

Introduction, pp. 5-7. Tables of contents of the reports, pp. 9-45. Corrections of errata, pp. 46-51. Notes and additions of the most important facts ascertained about insects treated in the reports [with later or more correct nomenclature], pp. 52-63. Descriptions of new species and varieties [reprinted from the reports with notes and corrections], pp. 64-90. List of descriptions of adolescent states [referring to previously published descriptions of the same when any exist], pp. 91-95. List of descriptions of adolescent states [referring to previously published descriptions of the same when any exist], pp. 91-95. List of descriptions, mostly amplified, of species not new, pp. 96-97. List of illustrations [arranged in serial order, designating those not original], pp. 98-118. Classified list of illustrations [in systematic order], pp. 119-123. General index, pp. 125-166. Index to plants and food-plants, pp. 167-177. Errata [in this work], p. 178.

— Notes on North American *Microgasters*, with description of new species.

(Trans. Acad. Sci. St. Louis, iv, No. 2, pp. 295-315; il.)

Separate [St. Louis], 6 April, 1881,  $\frac{1}{2}$  t. p. cover + 20 p., 23 x 16, il. Habits and characteristics of the group; three genera distinguished; formations of cocoons (il.); describes two new species of *Microplitis* and ten of *Apanteles*; also several forms of *Apanteles congregatus* and larva of *A. aletia*; figures imago of *A. aletia* and several cocoon masses; habits of the species; reference list of the (23) described N. A. species.

## RILEY, CHARLES V.—On some interactions of organisms.

(Amer. Naturalist, April 1881, xv, p. 323, 324.)

Abstract of and comments on S. A. Forbes's "On some interactions of organisms" (Bull. Ill. State laboratory of Nat. History, No. 3).

## — Legislation to control insects injurious to vegetation.

(Farmers' Review, Jan. 20, 1881. Reprint Amer. Naturalist, April, 1881, xv, pp. 322-323. Indiana Farmer, April 15, 1881.)

## — Agricultural advancement in the United States. Reprint, entitled "Agricultural advancement in the United States." Address at the organization of the American Agricultural Association, December, 1879.

(Journ. Amer. Agric. Assoc., April, 1881, i, pp. 47-54.)

Account of the measures adopted by the governments of England, Germany, and France for the promotion of agriculture; criticism of the U. S. Department of Agriculture and suggestions for its reorganization; how the present association can do its work best.

— The Periodical Cicada, *alias* "Seventeen-year Locust."

(Amer. Naturalist, June, 1881, xv, pp., 479-482, Fig. 1.)

## — A new species of oak Coccid, mistaken for a gall.

(Amer. Naturalist, June, 1881, xv, p. 482.)

Description of *Kermes galliformis*, n. sp., occurring on *Quercus palustris* in the southern and central U. S.; the Coccid often infested by a parasitic Lepidopter, *Euclomensia bassettella*.

## — The "Water-weevil" of the rice plant.

(Amer. Naturalist, June, 1881, xv, pp. 482-483.)

Reasons for presuming that the "maggot" of rice-fields is the larva of *Lasiorhoptrus simplex*; habits and seasons of appearance.— The impregnated egg of *Phylloxera vastatrix*.

(Amer. Naturalist, June, 1881, xv, pp. 483-484.)

Establishment of the author's prediction, made in 1875, that the impregnated egg of *Phylloxera vastatrix* would be found to hatch in the same season in which it was laid.

## — Works on North American Micro-lepidoptera.

(Amer. Naturalist, June, 1881, xv, pp. 484-486.)

Review of Lord Walsingham's [T. de Grey's] "Illustrations of typical specimens of *Lepidoptera heterocera* . . . pt. 4," and of his "*Pterophorida* of California and Oregon;" discussion of the new genera erected therein.— Moths mistaken for *Aletia*.

(Amer. Naturalist, June, 1881, xv, pp. 486-487.)

## — Scale insect on raspberry.

(Amer. Naturalist, June, 1881, xv, p. 487.)

— Specific value of *Apartura alicia*, Edw.

(Amer. Naturalist, June, 1881, xv, p. 487.)

## — The caterpillar nuisance. How to suppress it.

(Evening Star [Washington, D. C.], 24th June, 1881. Amer. Naturalist, Sept., 1881, xv, pp. 747-748, fig.)

## RILEY, CHARLES V.—Plant-feeding habits of predaceous beetles.

(Amer. Naturalist, April, 1881, xv, pp. 325-327.)

Brings together various testimonies to prove that certain *Carabida* and *Coccinellida* feed upon vegetal matter, referring to published articles on the subject.

Notes on *Papilio philenor*.

(Amer. Naturalist, April 1881, xv, pp. 327-329, Fig. 1-3.)

Describes egg and newly-hatched larva; figures imago, larva, and pupa; notes on distribution and food-plant (*Aristolochia*.)

## Larval habits of Bee-flies.

(Amer. Naturalist, June, 1881, xv, pp. 438-447, pl. 6.)

Extract from chap. 13 of 2d rept. U. S. Entom. Commission. Parasitism of larvæ of *Triodites mus* and *Systoechus oreas* on eggs of *Camnula pellucida*; review of previous knowledge of the larval history of *Bombyliida*, with references to the several accounts of observations; description of larvæ and pupæ of *T. mus* and *S. oreas*, and figures of these and of the imagos.

Additional notes on the Army worm, *Leucania unipuncta*.

(Proc. Amer. Assoc., Advanc. Sci. for 1881, xxix, p. 640.)

Revision of views set forth in op. cit. for 1876, 1877, v. 25, pt. 2, p. 279: number of annual generations two to several, according to latitude; both larva and imago hibernate, probably pupa also; the insects may occur in destructive numbers from natural increase or from immigration; they breed naturally in all old, neglected fields; dry seasons favorable to the increase of the insects in the following year.

## Some recent practical results of the cotton worm inquiry by the U. S. Entomological Commission.

(Proc. Amer. Assoc. Advanc. Sci., 1881, xxix, p. 642.)

Statement of principles established in the natural history of *Aletia argillacea*, which have a practical bearing; the best poisons for the insects are Paris green, London purple, pyrethrum, and oils; methods of applying these poisons.

## The hitherto unknown life-habits of two genera of bee-flies, bombyliidæ.

(Proc. Amer. Assoc. Advance. Sci., 1881, xxix, pt. 2, p. 649.)

## Lepidopterological notes.

(Papilio, July, 1881, i, pp. 106-110.)

From advance sheets of Bulletin 6, U. S. Entom. Commission. Synonymical and biological notes, with references to literature concerning *Plusia brassica*, *Gortyna nitela*, *Anomis xyliana*, *Pempelia grossularia*, *Penthina vitivorana*, *Endemis botrana*, *Euryptychia saligneana*, *Hedya scudderiana*, *Anchylopera fragaria*, *Tortrix cinderella* and *T. malivorana* and *T. vacciniivorana*, *Teras oxycoocana*, *Oeta compta* and *Tinea pustulella* and *Deiopeia aurea*-*Oeta punctella*; describes eggs of *Teras oxycoocana* and *Oeta punctella*.

## The Periodical Cicada, alias "Seventeen-year Locust."

(Farmers' Review, June 16, 1881.)

Statement of localities in which *Cicada septemdecim* Linn will occur in 1881, and also of those in a thirteen-year race (*tredecim* Riley) will appear.

RILEY, CHARLES V.—Locusts and Locusts. A letter from Professor C. V. Riley. The head of the United States Entomological Commission explains the difference between the periodical Cicada and the true Locust: thirteen- and seventeen-year broods: no especial cause for alarm this year.

(New York Tribune, June 22, 1881.)

Popular confusion of insects having very different habits under the term "locust." Comparative account of *Cicada septendecim* with *Caloptenus spretus*. No cause for the alarm as to true locust depredations. Recommendation of a system of observations and warnings by the Government.

— The Rocky Mountain Locust, alias Western Grasshopper. (American Agriculturist, July, 1881, vol. xl, p. 283, 284, fig. 1-6.)

Popular condensed statement of habits and remedies for *Caloptenus spretus*.

— A remarkable case of retarded development.

(Scientific American, Aug. 20, 1881.)

Preservation of eggs of *Caloptenus spretus* unhatched for more than four years by their burial in a cool, moist and almost air-tight place, at Manhattan, Kansas, 1876-1881; influence of temperature on acceleration and retardation of development.

— The Rocky Mountain Locust, alias Western Grasshopper.

(Amer. Agriculturist, July, 1881, Fig. 1-6.)

— Dimorphism in *Cynipidæ*.

(Amer. Naturalist, July, 1881, xv, p. 566.)

Claim of priority in proof of dimorphism in *Cynipidæ* in N. A.; reference to previous views of Walsh and Bassett; extract from H. Adler's "Über den Generationswechsel der Eichen-Gallwespen" (Zeitschr. für wiss. Zool., Feb., 1881, Bd. 35, p. 151 —), comprising a list of the 19 specimens in which the occurrence of dimorphic forms has been proven.

— *Blepharoceridæ*.

(Amer. Naturalist, July, 1881, xv, p. 567-568.)

Account of various investigations into the natural history of *Blepharoceridæ*; description of the larvæ and pupæ.

— The cultivation of Pyrethrum and manufacture of the powder.

(Amer. Naturalist, July, Sept., and Oct., 1881, pp. 569-572; pp. 744-746; and pp. 817-819.)

— Covering of egg-puncture mistaken for *Dorthesia*.

(Amer. Naturalist, July, 1881, xv, p. 574.)

In the collection of Asa Fitch the white and ribbed waxy material covering the egg-punctures of *Enchophyllum binotatum* are labeled as *Dorthesia viburni* and *D. oelastri*. It is doubtful whether any such species were described by Fitch.

— Supposed Army-worm in New York and other Eastern States.

(Amer. Naturalist, July, 1881, xv, pp. 574-577.)

Ravages of *Nephelodes violans* and *Crambus vulginagellus*, in New Jersey, Long Island, and Northern New York—natural history, vernacular name, and detailed description of larva of the former species.

## RILEY, CHARLES V.—Classification of the mites.

(Amer. Naturalist, July, 1881, xv, pp. 577-578.)

Abstract of letter from Dr. G. Haller, in which he states that *Acarina* have three pairs of maxillæ, a true labium with palpi, two pairs of abdominal and [two pairs of] cephalothoracic legs; he does not consider that they belong to the *Arachnida*, but believes they are much more nearly allied to the *Crustacea*, and must form a fifth class of *Arthropoda*, equivalent to *Crustacea*, *Myriapoda*, *Arachnida*, and *Hexapoda*.

— Further notes on the pollination of *Yucca* and on *Pronuba* and *Prodoxus*.

(Proc. Amer. Assoc. Advanc. Sci., 1881, xxix, pt. 2, pp. 617-639, Fig. 1-16.)

— Separate. (Further notes [etc.])

[Salem, July, 1881,] pp. 1-23, Fig. 1-16.)

Recapitulation of observed facts concerning *Pronuba yuccasella* and its connection with the pollination of *Yucca*; describes and figures the generic and specific characters of *Pronuba*, *P. yuccasella*, *P. maculata* n. sp., *Prodoxus*, *P. decipiens*, *P. intermedius* n. sp., *P. marginatus* n. sp., *P. cinereus* n. sp., *P. æneocens* n. sp., *Hyponomeuta*, *H. malinella*, *H. multipunctella*; establishes and characterizes the new family *Prodoxidae* (*Tineina*) for *Pronuba* and *Prodoxus*; discusses the structure of the ovipositor in lepidoptera, and the habits and functions of *Pronuba yuccasella* and *Prodoxus decipiens*; proposes to restrict the prior trivial name *quinguspunctella* [proposed for a *Yponomeuta*] to that form of *Prodoxus decipiens* which it proves to be, and cites the trivial name *paradozica* [used without description] as a synonym of *P. decipiens*.

— The periodical Cicada.

(Amer. Agriculturist, Aug., 1881, Fig. 1-5.)

— *Blepharocercidæ*.

(Amer. Naturalist, Sept., 1881, xv, p. 748.)

Records the discovery, by J. Q. Adams, of pupæ and imagoes of *Blepharocercidæ* at Watertown, N. Y.

— Remarkable case of retarded development.

(Amer. Naturalist, Sept., 1881, xv, pp. 748-749.)

Eggs of *Caloptenus spretus*, buried about 25 cm. under ground, remained unhatched and alive for four and one-half years, at Manhattan, Kansas, and hatched upon being exhumed.

— The Hessian fly.

(Amer. Naturalist, Sept., 1881, xv, p. 750.)

Report of extensive damage done by *Cecidomyia destructor* in Illinois and Missouri; abundance of this insect in the Western [prairie] States.

— The genuine Army-worm in the West.

(Amer. Naturalist, Sept., 1881, xv, p. 750.)

— A new imported enemy to clover.

(Amer. Naturalist, Sept., 1881, xv, pp. 750-751.)

*Trifolium* injured by *Phytonomus punctatus* at Barrington, N. Y., in July, 1881.

— Another enemy of the rice plant.

(Amer. Naturalist, Sept., 1881, xv, p. 751.)

*Oryza sativa* greatly injured in Georgia, in the summer of 1881, by the larvæ of *Laphygma frugiperda*.

## RILEY, CHARLES V.—Lepidopterological notes.

(Amer. Naturalist, Sept., 1881, xv, pp. 751-752.)

Notes on *Egeria acerni*, *Hyphantria textor*, *Callimorpha fulvicosta*, *Samia columbia*, *Callosamia angulifera*, *Celæna renigera* and *Prodenia autumnalis*.Notes on *Hydrophilus triangularis*.

(Amer. Naturalist, Oct., 1881, xv, pp. 814-817, Fig. 1-2.)

Notes on the life-history of *H. triangularis*: figures eggs, egg-cases, larva, pupa, and imago.

## Migration of plant-lice from one plant to another.

(Amer. Naturalist, Oct., 1881, xv, pp. 819-820.)

Review and indorsement of Lichtenstein's views.

## The Chinch Bug.

(Amer. Naturalist, Oct., 1881, xv, pp. 820-821.)

Notice of Thomas's predictions, and of the occurrence of *Blissus leucopterus* on rice and "sand oats."

## The Permanent Subsection of Entomology at the recent meeting of the A. A. A. S.

(Amer. Naturalist, Nov. and Dec., 1881: xv, pp. 909-912; and pp. 1008-1011.)

## The new imported clover enemy.

Habits of *Phytonomus punctatus*, and of other species of the genus.

(Amer. Naturalist, Nov., 1881, xv, pp. 912-914.)

*Crambus vulgivagellus*. (Description of its eggs.)

(Amer. Naturalist, Nov., 1881, xv, pp. 914-915.)

[Address delivered 4 Nov., 1881, at the cotton convention held in Atlanta, Ga., 2 Nov., 1881.] (U. S. Department of Agriculture.)  
Address of Hon. Geo. B. Loring, Commissioner of Agriculture, and other proceedings of the cotton convention [etc.], Wash., 1881, pp. 19-35.

Beneficial and injurious influence of insects; methods of counteracting injurious insects; ravages and natural history of and search for means against *Aletia argillacea*; improved methods and contrivances for the application of poisons to plants; discussion on the address.

Larval habits of *Sphenophori* that attack corn.

(Amer. Naturalist, Nov., 1881, xv, pp. 915-916.)

Mentions several species of *Sphenophorus* injurious to maize plants in different parts of the United States; habits and ravages of *S. robustus*.

## Effect of drought on the Hessian fly.

(Amer. Naturalist, Nov., 1881, xv, p. 916.)

Hot and dry weather dries up and kills *Cecidomyia destructor* and its parasites.

## Retarded Development in Insects.

(Amer. Naturalist, Dec., 1881, xv, pp. 1007-1008.)

Eggs of *Caloptenus spretus* retained their vitality four and one-half years under abnormal environment, and then hatched on exposure to normal environment; speculations on the cause of the phenomena of retardation of development.



RILEY CHARLES V.—Another herbivorous Ground-beetle.

(Amer. Naturalist, Dec., 1881, xv, p. 1011.)

*Anisodactylus confusus* injuring strawberry plants in California.

—— A disastrous sheep parasite.

(Amer. Naturalist, Dec., 1881, xv, p. 1011.)

*Trichodectes ovis* doing great injury to flocks of sheep in Illinois.

—— Resistance of grape-vines to *Phylloxera* in sandy soil.

(Amer. Naturalist, Dec., 1881, xv, pp. 1012-1013.)

—— Locusts in the West in 1881.

(Amer. Naturalist, Dec., 1881, xv, p. 1013.)

—— The Chinch Bug.

(Amer. Agriculturist, November, 1881, vol. xl, p. 476, fig. 1-3; *ibid.*, December, 1881, vol. xl, p. 515, fig. 1-4.)

Destructive powers, food-plants, characters, habits, natural history, meteorological conditions affecting, natural enemies of, and means of coping with *Blissus leucopterus*, Say. Describes as enemies *Anihocoris insidiosus*, *Harpactor cinctus*, and *Nysius destructor*; also some false or bogus chinch bugs. Lays stress on value of irrigation.

—— Peach Tree Bark-borer. Important note from Professor C. V. Riley.

(Rural New Yorker, Dec. 24, 1881.)

Account of injuries to peach trees of a beetle, *Phloeotribus liminaris*, Harr.

SHUFELDT, R. W., M. D.—The Claw on the Index Finger of the *Cathartidæ*.

(Amer. Naturalist, November, 1881, xv, pp. 906-908.)

An important osteological paper based upon material in the collection of the National Museum.

—— On the Ossicle of the Antibranchium as found in some of the North American *Falconidæ*.

(Bull. Nutt. Orn. Club., Oct., 1881, vol. vi, pp. 197-203.)

An important osteological paper based chiefly on material contained in the National Museum collection.

WARD, LESTER F.—Evolution of the Chemical Elements.

(Popular Science Monthly, February, 1880, pp. 526-539.)

A discussion of the theory of development as applied to the elements and consideration of the facts recently revealed by spectrum analysis seeming to favor the theory.

Previously read before the Philosophical Society of Washington.

—— Incomplete Adaptation as illustrated by the History of Sex in Plants.

(Amer. Naturalist, February, 1881, pp. 89-95.)

Read before the Biological Section of the American Association for the Advancement of Science at Boston August 27, 1880.

The paper shows that there exist, in nearly all departments of the vegetable kingdom, successive degrees to which the process of sexual differentiation has attained, and that in many cases there are obvious indications that this process is still going on.

## WARD, LESTER F.—Pre-Social Man.

(Abstract of Transactions of the Anthropological Society of Washington, for the years ending January 20, 1880, and January 18, 1881, pp. 68-71, being the abstract of a paper read before the Society April 20, 1880.)

The anatomical characters distinguishing the human form from that of the most highly developed anthropoids are enumerated, and the several physical causes considered which seem to have been most potent in securing their development.

## Savage and Civilized Orthoëpy.

(Loc. cit., pp. 106-111 being the abstract of a paper read before the Society December 21, 1880.)

This paper consisted, principally, of remarks and strictures on the first chapter of the *Introduction to the Study of Indian Languages*, by J. W. Powell, Ph. D., Director of the Bureau of Ethnology, which treats of the pronunciation of Indian and other languages.

## Politico-Social Functions.

(Penn. Monthly, May, pp. 321-336. Read before the Anthropological Society of Washington March 15, 1881.)

The right, power, and duty of society to regulate its own operations are argued, and the progress which has taken place toward this end in various countries is reviewed.

## Field and Closet Notes on the Flora of Washington and Vicinity.

(Bulletin of the Philosophical Society of Washington, 1881, vol. iv, pp. 64-119. Read before the Society January 22, 1881.)

The paper embraces, among other sub-titles, a *Comparison of Flora of 1830, with that of 1880*; a description of the *Localities of Special Interest to the Botanist*; a consideration of the *Flowering-time of Plants*; a *Statistical View of the Flora as compared with other floras*; an enumeration of the most *Abundant Species*; a statement of the most approved *Classification Adopted* by botanists; remarks on *Common Names*, and a *Summary* by Orders and larger groups of the number of genera and species found growing in the vicinity of Washington.

## WHITE, CHARLES A., on certain Cretaceous fossils from Arkansas and Colorado.

(Proc. U. S. N. M., iv, p. 136-139. 1 pl.)

## II.—PAPERS BY INVESTIGATORS NOT OFFICERS OF THE MUSEUM.

## BENDIRE, CAPT. CHARLES, U. S. A.—Notes on Salmonidæ of the Upper Columbia.

(Proc. U. S. N. M., iv, pp. 81-87.)

## BREWSTER, WILLIAM.—Notes on some Birds from Arizona and New Mexico, with a description of a supposed new Whip-poor-will.

(Bull. Nutt. Orn. Club, April, 1881, vol. vi, pp. 65-73.)

*Antrostomus vociferus arizonæ*, var. nov. (p. 69), is based partly on the examination of specimens contained in the collection of the National Museum.

BREWSTER, WILLIAM.—Critical notes on a Petrel new to North America.

(Bull. Nutt. Orn. Club, April, 1881, vol. vi, pp. 91-97.)

A specimen of an *Estrelata* captured alive in a plowed field at Mount Morris, Livingston County, New York, was identified by Mr. Brewster by comparison with the type specimen in the National Museum, as *Æ. gularis* (Peale).

——— On the affinities of certain Polioptilæ, with a description of a new species.

(Bull. Nutt. Orn. Club, April, 1881, vol. vi, pp. 101-107.)

Based largely on specimens in the collection of the National Museum, among which are the types of *P. californica* Brewst., sp. nov. (p. 103).

COLLINS, CAPT. J. W.—Gill-nets in the cod fishery: A description of the Norwegian cod nets, with directions for their use, and a history of their introduction into the United States.

(Bull. U. S. F. C., 1881, vol. i, pp. 1-17, 12 pl.)

ENDLICH, F. M.—An analysis of water destructive to fish in the Gulf of Mexico.

(Proc. U. S. N. M., iv, p. 124.)

FARLOW, W. G.—Report on the contents of two bottles of water from the Gulf of Mexico; forwarded by the Smithsonian Institution.

(Proc. U. S. N. M., iv, p. 234.)

GAERMAN, SAMUEL.—Synopsis and descriptions of the American *Rhinobatidæ*.

(Proc. U. S. N. M., 1880, iii, pp. 516-523.)

GILL, THEODORE.—Note on the Latiloid genera.

(Proc. U. S. N. M., 1881, iv, pp. 162-164.)

GLAZIER, W. C. W., ASSISTANT SURGEON, M. H. S.—On the destruction of fish by polluted waters in the Gulf of Mexico.

(Proc. U. S. N. M., iv, pp. 126-127.)

GURNEY, JOHN HENRY.—Note on *Onychotes grueberi*, Ridgway.

(The Ibis (London), July, 1881, 4th ser., vol. v, pp. 396-398, pl. xii.)

This article and the fine plate accompanying it is based on the two type specimens in the U. S. National Museum collection, the only examples of the species known to exist.

HARGER, OSCAR.—Report on the Marine Isopoda, of New England, and adjacent waters.

(Rept. U. S. Comm. Fish and Fisheries, part vi, pp. 297-462, plates i-xiii).

"The following paper includes the species of Isopoda at present known to inhabit the coast of New England and the adjacent region, as far as Nova Scotia on the north and New Jersey on the south." This is a very complete account of all the New England Isopods known up to the date of publication, full descriptions being given of all the families, genera, and species, and detailed figures of all the species. Fourteen families, 34 genera, and 46 species are described; of these one genus and one species (*Syscenus infelix*) are new. An account of the geographical distribution of the species described is given, followed by a table illustrating their geographical and bathymetrical range in detail, and a list of the authorities quoted.

HAY, O. P.—On a collection of fishes from eastern Mississippi.

(Proc. U. S. N. M., 1880, iii, pp. 488-515.)

The following new species are described: *Ammocrypta gelida*, *Hadropterus spillmani*, *Nanostoma elegans*, *Pœcilichthys artesiæ*, *P. saxatilis*, *Vaillantia chlorosoma*, *Microperca præliaris*, *Alburnops taurocephalus*, *Alburnops longirostris*, *Hemistremia maculata*, *Luxilus chickasawensis*, *Opsopæodus* (n. g.) *emilia*, *Minnilus punctulatus*, *Minnilus rubripinnis*, *Minnilus bellus*.

HENSHAW, H. W.—On *Podiceps occidentalis* and *P. clarkii*.

(Bull. Nutt. Orn. Club, Oct., 1881, vi, pp. 214-218.)

A critical comparison of the above-named forms, based chiefly on specimens in the collection of the National Museum.

INGERSOLL, ERNEST.—On the fish mortality in the Gulf of Mexico.

(Proc. U. S. N. M., iv, pp. 74-80.)

JOHNSON, S. H.—Notes on the mortality among fishes of the Gulf of Mexico.

(Proc. U. S. N. M., iv, p. 205.)

JORDAN, DAVID S.—Description of a new species of *Caranx* (*Caranx Beani*), from Beaufort, North Carolina.

(Proc. U. S. N. M., 1880, iii, pp. 486-488.)

JORDAN, DAVID S., and CHARLES H. GILBERT.—Description of a new species of *Nemichthys* (*Nemichthys avocetta*), from Puget Sound.

(Proc. U. S. N. M., 1880, iii, pp. 409-410.)

— Description of a new species of *Paralepis* (*Paralepis coruscans*), from the Straits of Juan de Fuca.

(Proc. U. S. N. M., 1880, iii, pp. 411-413.)

— List of the fishes of the Pacific coast of the United States, with a table showing the distribution of the species.

(Proc. U. S. N. M., 1880, iii, pp. 452-458.)

— On the generic relations of *Belone exilis* Girard.

(Proc. U. S. N. M., 1880, iii, p. 459.)

— Notes on a collection of fishes from Utah Lake.

(Proc. U. S. N. M., 1880, iii, pp. 459-465.)

— Description of a new species of "Rock Fish" (*Sebastichthys chrysomelas*) from the coast of California.

(Proc. U. S. N. M., 1880, iii, pp. 465-466.)

— Notes on the fishes of the Pacific coast of the United States.

(Proc. U. S. N. M., iv, pp. 29-70, Apr. 13-30, 1881.)

— Description of *Sebastichthys mystinus*.

(Proc. U. S. N. M., iv, pp. 70-72.)

— Description of a new species of *Ptychochilus* (*Ptychochilus Harfordi*) from Sacramento River.

(Proc. U. S. N. M., iv, pp. 72-73.)

— Note on *Raia inornata*.

(Proc. U. S. N. M., iv, pp. 73-74.)

JORDAN, DAVID S., and PIERRE L. JOUY. Check list of duplicates of fishes from the Pacific coast of North America, distributed by the Smithsonian Institution in behalf the United States National Museum, 1881.

(Proc. U. S. N. M., iv., pp. 1-18.)

LAWRENCE, GEORGE N.—Description of a new subspecies of *Loxigilla* from the island of St. Christopher, West Indies.

(Proc. U. S. N. M., iv, p. 204.)

*Loxigilla portoricensis* var. *grandis*, types in collection of the National Museum.

LOCKINGTON, W. N.—Description of a new species of (*Prionotus stephanophrys*) from the coast of California.

(Proc. U. S. N. M., 1880, iii, pp. 529-532.)

——— Description of a new genus and species of *Cottidæ*.

(Proc. U. S. N. M., iv, pp. 141-144.)—(*Chitonotus megacephalus*.)

McKAY, CHARLES L.—A review of the genera of the family *Centrarichidæ*, with a description of one new species.

(Proc. U. S. N. M., iv, pp. 87-93.)

MOORE, M. A.—Fish mortality in the Gulf of Mexico.

(Proc. U. S. N. M., iv, pp. 125-126.)

PORTER, JOSEPH Y., ASSISTANT SURGEON, U. S. A.—On the destruction of fish by poisonous water in the Gulf of Mexico.

(Proc. U. S. N. M., iv., pp. 121-123.)

RYDER, J. A.—Preliminary notice of the more important scientific results obtained from a study of the embryology of fishes.

(Bull. U. S. F. C., i, pp. 22-23.)

——— Notes on the development, spinning habits, and structure of the four-spined stickleback.

(Bull. U. S. F. C., i, pp. 24-29.)

——— Development of the Spanish mackerel (*Cybius maculatum*).

(Bull. U. S. F. C., i, pp. 135-173, 4 pl.)

——— On the retardation of the development of the ova of the shad, (*Alosa sapidissima*), with observations on the egg-fungus and bacteria.

(Bull. U. S. F. C., i, pp. 177-190.)

——— A contribution to the development and morphology of the Lophobranchiates—(*Hippocampus antiquorum*, the sea horse).

(Bull. U. S. F. C., i, pp. 191-199, 1 pl.)

SCLATER, P. L.—Remarks on the recently described parrots of the genus *Chrysotis*.

(The Ibis [London], July, 1881, 4th ser., v, pp. 411-414.)

Based in part upon National Museum Specimens.

**SHOEMAKER, GEORGE.**—Abundance of the Hermit Thrush in Winter near Washington, D. C.

(Bull. Nutt. Orn. Club, April, 1881, vol. vi, pp. 113, 114.)

A specimen of the above-named species was obtained January 1, the mercury registering  $-14^{\circ}$ , and is now in the National Museum collection. The species was quite common during the coldest weather of the severe winter of 1880-'81.

**SMITH, ROSA.**—Description of a new gobioid fish (*Othonops eos*), from San Diego, California.

(Proc. U. S. N. M., iv, pp. 19-21.)

Synonym of *Typhlogobius californiensis* Steind.—See Proc., iv, 140.

——— Description of a new species of *Gobiesox* (*Gobiesox rhessodon*), from San Diego, California.

(Proc. U. S. N. M., iv, pp. 140-141.)

**SMITH, S. I.**—Preliminary notice of the crustacea dredged, in 64 to 325 fathoms, off the south coast of New England by the United States Fish Commission in 1880.

(Proc. U. S. N. M., 1880, iii, pp. 413-452.)

An enumeration of the principal crustacea obtained by the United States Fish Commission, in 1880, from the inner edge of the Gulf Stream slope, south of Newport, R. I., with notes on the previously-known species and descriptions of one new genus and fourteen new species. Four additional species are mentioned as new without descriptions. The total number of species recorded is 50. The paper closes with a table showing the geographical and bathymetrical range of the species.

**STONE, LIVINGSTON.**—Mortality of McCloud River Salmon in 1881.

(Bull. U. S. F. C., i, p. 134.)

**VERBIL, A. E.**—The Cephalopods of the Northeastern Coast of America. Part II. The Smaller Cephalopods, including the "Squids" and Octopi, with other allied forms.

(Trans. Conn. Acad. Arts and Sci., 1881, vol. v, pp. 259-424, plates 26-56.)

This "is a monographic revision, with descriptions and figures of all the species. A considerable amount of anatomical work is also introduced. Most of the species had previously been noticed in different articles in the American Journal of Science. Among those not previously described are *Chiroteuthis lacertosa*, *Brachioteuthis Beanii*, gen. et. sp. nov., *Rossia megaptera*. A new genus (*Stoloteuthis*) has also been established for *Sepiola leucop-tera* V."

## ——— New England Annelida. Part I. Historical sketch, with annotated lists of the species hitherto recorded.

(Trans. Conn. Acad., 1881, vol. iv, pp. 285-324.)

"In connection with the annotation, a considerable number of changes in nomenclature are introduced, and a few new genera are established."

## ——— Recent papers on the marine invertebrata of the Atlantic coast of North America:

(Am. Journ. Sci., Nov., 1881, vol. xxii.) A list with brief notes.

S. Mis. 109—9

VERRILL, A. E.—Notice of Recent Additions to the Marine Invertebrata of the northeastern coast of America, with descriptions of new genera and species and critical remarks on others. Part II.—Mollusca, with notes on Annelida, Echinodermata, etc., collected by the United States Fish Commission.

(Proc. U. S. N. M., 1880, iii, pp. 356–405.)

Part III.—Catalogue of Mollusca recently added to the Fauna of Southern New England.

(Proc. U. S. N. M., 1880, iii, pp. 405–409.)

Part II of this report begins with an account of the dredgings made by the U. S. Fish Commission, south of Newport, R. I., in 1880, and a list of the deep-water stations one hundred and forty species of Mollusca are recorded, of which one genus and 22 species are new; 96 additional species are stated to be new additions to the North American marine fauna, including 25 species recently described from the collections of 1880. Two new species of annelids are also described. Part III is a table illustrating the geographical and bathymetrical distribution of 130 species of Mollusca, recently added to the fauna of Southern New England, mainly through the dredgings of the U. S. Fish Commission of 1880.

——— Notice of the remarkable Marine Fauna occupying the outer banks off the Southern coast of New England.

Brief Contributions to Zoology from the museum of Yale College. No. xlviii.)

(Am. Journ. Sci., Oct., 1881, vol. xxii, pp. 282–303.)

A general account of the dredging operations of the U. S. Fish Commission, during the summer of 1881. A list of the deep-water stations south of Martha's Vineyard, with temperature observations, is given, and also a list of the deep-water fishes, so far as determined up to date of publication, by Dr. T. H. Bean. A list of the Cephalopods obtained from deep water is included, and five new species of Gasteropods and Lamellibranchs are described.

——— Reports on the Results of Dredging, under the supervision of Alexander Agassiz, by the United States Coast Survey steamer "Blake." Report on the Cephalopods, and on some additional species dredged by the United States Fish Commission steamer "Fish Hawk," during the season of 1880.

(Bull. Mus. Comp. Zoology, 1881, viii, pp. 99–166. 8 plates.)

WILSON, EDMUND B.—Report on the Pycnogonida of New England and Adjacent Waters.

(Rep't U. S. Comm. Fish and Fisheries, part vi, pp. 463–506, plates i–vii.)

"An account of our present knowledge of the species of Pycnogonida, known to occur upon the coasts of New England and Nova Scotia, comprising descriptions and figures of all the forms, and an account of their geographical and bathymetrical distribution." A synopsis of the genera is given. Nine genera and fifteen species are described, two species (*Achelia scabra* and *Nymphon macrum*) being new.

APPENDIX C.—LIST OF CONTRIBUTORS TO THE MUSEUM  
IN 1881.

- Academy of Natural Sciences, Philadelphia, Pa.* (See *Philadelphia*.)
- Adams, J. C.* A water-worn pebble of Trenton limestone, containing the fossil *Receptaculites occidentalis*; from Wisconsin. (For examination.)
- Adams, J. Q.* Living salamander (*Amblystoma punctatum*) and eggs of horned toad (*Phrynosoma* ?); from New York.
- Allen, Charles.* Seventy-six specimens of Pennsylvania building stones and slates.
- Albert, J. C., Paoli, Ind.* Eleven specimens of Indiana building stones.
- Allen, Charles A.* Box of birds' skins (*Colaptes, Zonotrichia*, etc.); from California.
- Allen, Rev. J.* Stone pipe, tube, and ring; from New York. (Lent for casting.)
- Alice Gold and Silver Mining Company, Montana.* Specimens of gold and silver bearing *Galena* and *Rhodochrosite*, etc.
- Alcock, S. & Co., Redditch, England.* Three snoods with patent covers for protection of hooks.
- Allison, Hon. W.* Specimen of coal; from Iowa. (Sent for examination.)
- American Encaustic Tiling Company, New York.* Fourteen samples of floor tiles.
- American Museum of Natural History, New York.* (See *New York*.)
- Anderson, Capt. Charles, schooner Alice G. Wonson.* Two bottles of alcoholic specimens of fishes.
- Anglo-American Packing Company, Astoria, Oregon.* Two samples of cans and labels used in the packing of salmon.
- Anthropological Society, Washington, D. C.* (See *Washington, D. C.*)
- Ash, Charles E. (through Samuel Albro).* Forty-five pearls taken from a single oyster found in Providence Bay.
- Ashburner, Charles.* Twenty-one specimens of Pennsylvania building stones.
- Aspinwall & Son, New York.* Samples of floor tiling.
- Astoria Packing Company, Astoria, Oregon.* Samples of cans and labels used in the packing of salmon.
- Atkins, Hon. J. D. C.* Specimens of coal and ore; from Tennessee. (Sent for examination.)
- Atkinson, Hon. Edward.* A large number of samples of manufactured cotton from various mills in the United States.



- Atwood, H. E.* Five microscopic slides of the water of Hemlock Lake, New York.
- Auckland, (N. Z.) Museum.* A keg of alcoholic specimens of New Zealand fishes (*Kathetostoma*, *Acanthoclinus*, *Latris*, *Zeus*, *Pagrus*, *Rhombosolea*, etc.)
- Austin Flagstone Company, Warren, Ohio.* Two specimens of Ohio building-stones.
- Australian Museum (Sydney, New South Wales).* A collection of Australian mammals (fifteen species), fishes (sixty-seven species), reptiles (twelve species), and echinoderms (five species).
- Babbitt, F. E.* Specimens of chipped quartz; from Minnesota.
- Babcock, Master C. E.* Starfish and shell of king-crab; from Cape Henry, Va.
- Babcock, Dr. S. E.* A small collection of Indian relics—pipes, arrow-heads, axes, etc.; from South Carolina.
- Bacon, A. W., Paymaster, U. S. Navy.* A collection of butterflies from Central and Western Africa and Brazil.
- Badollet & Co., Astoria, Oregon.* Samples of cans and labels used in packing salmon.
- Bahne, William.* Specimens of lamprey eels from the Susquehanna River, and foot of mink taken from trap; from Pennsylvania.
- Bailey, George K.* Two specimens of Maryland building-stones.
- Baird, Prof. S. F.* Cake of "Turtle Oil" soap, R. Low & Son, makers, London, England.
- Baker, G. C.* Specimens of fossils, minerals, and arrow-heads; from Missouri.
- Baker, Marcus, Assistant, United States Coast and Geodetic Survey.* Skull of walrus with tusks; from Plover Bay, Eastern Siberia.
- Baker, Thomas E.* Specimen of *Tuckahoe*; from Arkansas.
- Baker, W. C.* Specimen of *Melanura*; from Michigan.
- Baldwin, Miles C. (through John B. Wiggins).* A collection of fossil shells; from Tioga County, New York.
- Bangs, F. D.* A specimen of fresh-water sheepshead (*Haploidonotus grunniens*) sold as "German carp" in markets of Waterbury, Conn.
- Barker, Henry L.* Specimens of living snakes, terrapins, mud-eels, amphiumas, etc.; from South Carolina.
- Barker, William P.* Human skull and jaw-bones and fragments of pottery; from mound in Alabama.
- Barkley, W. F.* Samples of coke and coal; from Connellsville, Pa.
- Barney, George and R. J., Swanton, Vt.* Five samples of marble floor-tiling.
- Barnum, Hon. P. T.* A specimen of leopard, in flesh.
- Bartlett, J. H., and Sons, New Bedford, Mass.* A whaleboat and fittings as ready for service at sea. (Purchased ?)
- Baumeister, H., Portland, Me.* Samples of cans and labels used in packing herring, etc.

- Beach, H.* Arrow-point; from Wisconsin. Also eight copper implements lent for casting.
- Bean, George.* Two flax-hackles, one pair andirons, sickles, and one lard-oil lamp; from Pennsylvania.
- Bean, Dr. T. H.* Spear-heads and Venetian bead; from Pennsylvania; and a polishing stone from Santa Clara, N. Mex.
- Beardslee, Lester A., Captain U. S. Navy.* A collection of Indian implements and ornaments, specimens of shell (*Chiton*) used as food, and a bird skin (*Colaptes hybridus*); from Alaska.
- Beebe, William S.* Indian stone figure-pipe. (Lent for casting.)
- Belding, L.* Eight packages of collections of birds' skins, nests, and eggs, mammal skins, invertebrates, and Indian implements; from California.
- Belding Brothers, New York, N. Y.* A series of manufactured spool silks and twist, being exhibit made at Centennial Exhibition of 1876.
- Bell, Hon. James.* Fifteen packages of Indian implements, pottery, and mound remains, birds' skins and eggs, living snakes, plants, etc.; from Florida.
- Bell, Dr. Robert, Geological Survey of Canada.* A specimen of Darter (*Cottus*); from Lake Superior, and specimens of frogs and fishes, from York, Hudson's Bay Territory.
- Belt, Dr. A. M.* Two specimens of Maryland building-stones.
- Bence, John A.* Photograph of fossil tooth weighing 13½ pounds; found in Putnam County, Indiana.
- Bendire, Charles, Captain, U. S. Army.* Seventeen boxes of fossils and general natural history collections (mammals, birds, fishes, reptiles, etc.); from Washington Territory.
- Bessels, Dr. Emil.* A Lapland pipe and case, a box of European land shells, skeleton of bat (*Vespertilio murinus*) and seven Egyptian flint knives, and a skeleton of bat (*Vespertilio murinus*).
- Betz, A. L.* Two specimens of Missouri building-stones.
- Bickley, Dr. B. F. (through Dr. DeHaas).* A supposed syphilitic skull, obtained from mound at Alexandersville, Ohio.
- Blackford, Eugene G., New York.* A large number of specimens of fishes (*Alosa*, *Carpoides*, *Salmo*, *Ocyurus*, *Decapterus*, *Tautoga*, etc.), lobsters, from various parts of the United States, a specimen of Manatee from the Amazon River, and a box of living lizards and frogs from Liverpool, England.
- Boardman, George A.* Specimen of flounder (*Lophopsetta maculata*) and birds' skins (*Buteo*, *Tringoides*); from Florida.
- Boehmer, George H.* Specimens of owl (*Scops*), moles (*Scalops*), and of living snakes; from Maryland.
- Boucard, A.* A collection of Mexican and Yucatan birds.
- Bowers, Rev. Stephen.* A box of mound relics; from Wisconsin.
- Boyd, C. H., Assistant, United States Coast and Geodetic Survey.*—Scale from supposed fossil walrus-tusk found at Addison Point, Me.

- Bradford, Gershon* (through *Capt. C. P. Patterson, Superintendent, United States Coast and Geodetic Survey*). A box and barrel of oysters and specimens of bottom of Chesapeake Bay.
- Bradley, William, Washington, D. C.* Samples of marble floor-tiles.
- Bradolet & Co., Astoria, Oreg.* Samples of cans and labels used in the packing of salmon.
- Brady, Edward.* Specimens of mammals (*Ornithorhynchus*) and a bird-skin; from New South Wales.
- Bransford, John F., Passed Assistant Surgeon, U. S. Navy.* Two bricks taken from the "Great Wall of China."
- Briand, Capt. Augusté* (through *E. H. Hawley*). A box of stone implements; from France.
- Briggs Dean.* Two specimens of Ohio building stones.
- Broadhead, Prof. G. C.* Specimens of galena and sphalerite; from the Einstein mine, Madison County, Missouri.
- Broadhead, Prof. G. C.* A large collection of building stones from the States of Arkansas, Kansas, and Missouri.
- Brooks, W. B., Chief Engineer, U. S. Navy.* Swords, bullet-pouch, powder-charge, and wooden canteen, taken from the Koreans in 1871 by United States forces under Admiral John Rodgers, U. S. Navy.
- Brooks, Dr. W. K., Johns Hopkins University, Baltimore.* Alcoholic specimens of *Renilla*; from Beaufort, N. C.
- Brown, D. A.* Specimens of minerals. (For examination).
- Brown, Dr. J. J.* Five species of land shells; from the Gonave Islands.
- Brudon, Jacob.* A small box of shells; from Michigan.
- Brussels, Belgium, Royal Museum of Natural History.* Four boxes of general natural history specimens.
- Bryan, Rev. C. B.* Specimens of insects, shells, etc.; from Virginia.
- Bryce, T. T., Hampton, Va.* Samples of cans used for pickling oysters and crabs.
- Bucklin, W. E.* (through *E. G. Blackford*). A dried specimen of fish (*Boleosoma Olmstedii*).
- Burdick, T. W.* A specimen of fossil conglomerate; from Iowa.
- Burnham and Morrill, Portland, Me.* Samples of cans and labels used for packing fish, etc.
- Büsse, F.* Specimens of fishes (*Trigla, Solea, Trachurops, Tylosurus, Scomber*, etc.); from Germany.
- Butler, Hon. A. P.* Specimen of rock-fish (*Roccus lineatus*); from the Congares River, South Carolina.
- Bynum, J. G.* Specimen of flexible sandstone; from North Carolina.
- Bye, E. Mortimer.* Eight specimens of Maryland building-stones.
- Calder, D. B.* Two specimens of Ohio building-stones.
- California State Mining Bureau, San Francisco, Cal.* Casts of Indian stone pestles and image; from California and Arizona.
- Calvin, S.* Box of paleozoic fossils (sixty-three species); from Iowa.

- Cambria Iron Company, Philadelphia, Pa.* Photograph of Cambria Iron Works.
- Camp, W. B.* Box of Indian relics; from New York. (For casting.)
- Campbell, Charles D.* Natural formation of stone; from Ohio.
- Curll, John F.* Two specimens of Pennsylvania building-stones.
- Carson, N. R.* Specimens of infusorial earth; from California. (For examination.)
- Carson, Dr. W. B.* Indian stone ax; from Ohio.
- Carvar, Joseph H.* Specimens of salt herring; from Havre de Grace, Md.
- Case, Thomas S. (through Prof. O. T. Mason).* Fragment of cement; from an old aqueduct at Pecos, N. Mex.
- Catell, Dr. B.* Specimen of black sand; from Washington Territory. (For examination.)
- Catlin Collection.* A large buffalo skin, tent and poles, and skull of Flathead Indian.
- Caton, Judge J. D.* Bones of deer (*O. acapulcensis*) and skull of seventeen-months-old deer showing no horn-cores.
- Chambers, Alexander, Lieutenant-Colonel, U. S. Army.* Tooth of fossil elephant (*Elephas primigenius*); from Indian Territory.
- Chase, A. W.* Two boxes of fragmentary pottery taken from Aztec houses four feet below the surface, near Contention City, Ariz.
- Chase, C. H.* Two casts of stone implements; from Indiana.
- Chase, Walter G.* Specimen of massive quartz; from Massachusetts.
- Cheshire, William W.* Three arrow-heads; from Indiana; and cast of "paint cup"; from Wisconsin.
- Chester, H. C.* Box of crabs (*Callinectes hastatus*); from St. Jerome's Creek, Md.
- Cilley, C. W.* Two specimens of Vermont building-stones.
- City Drug Store, Nevada, Ohio.* Specimen of mole cricket (*Gryllotalpa borealis*). (For examination.)
- Clapp, A. F.* A living specimen of "map tortoise" (*Malacoclemmys geographicus*); from Pennsylvania.
- Clark, A. Howard.* Specimen of bat. Also specimen of embryo porpoise; from George's Banks.
- Clark, Edward, Architect U. S. Capitol.* A series of dressed blocks of stone used in the construction of the Capitol and other public buildings in Washington, D. C.
- Clark, Ellis, jr.* Specimens of fossil shells (*Bulimus, Unio*, etc.); from Texas.
- Clark, Frank N.* Specimens of white-fish eggs and living mud-dogs, (*Menobranhus lateralis*); from Michigan.
- Clark, M.* A large stone pipe taken from an Indian cemetery in Decatur County, Tennessee.
- Clark, O.* Specimen of slag. (For examination.)
- Clarke, Samuel F.* Specimens of *Amphioxus*; from Virginia.

- Clements, Luther M.* Specimens of quartz and chalcedony; from New Mexico.
- Coale, H. K.* Seven specimens, five species of birds.
- Cochecho Manufacturing Company, Dover, N. H.* Samples of printed cottons.
- Cocke, Thomas & Co.* A specimen of soap-stone; from North Carolina.
- Coe, Cornelius B.* Rat taken from under floor of Treasury Department while making repairs.
- Coke, Hon. Richard.* Specimen of bronze; from Texas. (For examination.)
- Cole, P. L.* Two specimens of Ohio building-stones.
- Coleman, E. C.* Specimen of mineral; from Wisconsin. (For examination.)
- Collier, David C.* Botanical specimens; from Colorado. (For examination.)
- Collins, J. W.* Model of mackerel-pocket used by Gloucester fishermen, a bottle of fishes and crustaceans from the Grand Banks, and as encysted fish-hook taken from flesh of halibut.
- Collins, W. H.* Specimens of birds' (*Ardea*, etc.) skins and eggs; from Michigan.
- Colton, H. E.* Forty-five specimens of building-stones; from the States of Alabama, Georgia, North Carolina and Tennessee.
- Commagere, A. Y.* Various relics of the *Polaris* expedition.
- Conway, John W. (through J. Stevenson.)* Five boxes of Indian ornaments, implements, etc.; from New Mexico.
- Conover, A. D., Chicago, Illinois.* A large collection of building-stones from the States of Illinois, Michigan, and Wisconsin.
- Cook, Prof. George H.* A large collection of building-stones and slates; from the States of New York and New Jersey.
- Copenhagen, Denmark, Royal Museum of Northern Antiquities.* Two boxes of antiquities from Denmark.
- Corning, Erastus, and H. A. Jewett.* Mounted skeleton of "Old Henry Clay," the progenitor of the *Clay* stock of racing horses.
- Corson, R. E.* Fourteen boxes of specimens (stalactites, etc.); from Luray Cave, Va.
- Cory, C. B.* Five specimens of birds; from Massachusetts.
- Cotell, Dr. B.* Specimen of magnetic sand; from Washington Territory.
- Coues, Elliott, Surgeon, U. S. Army.* A small box of bones of small mammals and fragments of pottery; from Cliff House on Beaver Creek, Arizona.
- Cowdrey & Co., Boston, Mass.* Samples of cans and labels used in the packing of fish, etc.
- Cowley, S. W.* Nine specimens of arrow and spear heads; from Connecticut and Ohio.

- Cox, ———. Two large specimens of East Indian shells, said to be from Chincha Islands.
- Craig, W. H. Specimens of silver ore; from Silver Cliff, Colo. (For examination.)
- Crandall, W. R. Stem of fossil, crinoid; from Collinsville, Ill.
- Crawford, A. W. Specimen of insects; from California.
- Crawford, C. Specimen of granite; from Dakota Territory.
- Crittenden, A. R. Three trawl-rollers used by the Gloucester fishermen.
- Croppie, Henry. Two living turtles (*Chelopus insculptus*); from New York.
- Cushing, Frank H. A Zuñi "sacred blanket;" from Fort Wingate, N. Mex.
- Cutting Packing Company, San Francisco, Cal. Samples of cans and labels used in packing fish, etc.
- Dale, F. C., Passed Assistant Surgeon, U. S. Navy. Two boxes of birds' skins and one box of alcoholic collections; from Japan.
- Dall, W. H., Assistant United States Coast and Geodetic Survey. Tusk of mammoth; from ice cliffs in Kotzebue Sound, 150 miles eastward from Bering Straits.
- Dalrymple, Dr. E. A. Specimens of *Tuckahoe*.
- Daniel & Boyd, St. Johns, N. B. Specimen of New Brunswick building-stone.
- Davenport, George G. Two small living alligators (*A. mississippiensis*); from Florida.
- Davis, Henry. Specimens of wasp and hornets' nests and four arrow-points; from Iowa.
- Davis, Hon. H. G. A large number of specimens of minerals; from West Virginia. (For examination.)
- Davis, Jabez. A large specimen of quahog clam; from Massachusetts.
- Dawkins, W. Boyd. Remains of bear and man taken from the hyæna dens of Creswell crags and *sink* in the limestone at Windy Knoll, Derbyshire, England.
- Dempsey, Thomas. Specimens of shad; from St. John's River, Florida.
- D'Invellier, E. V. Eighteen specimens of Pennsylvania building-stones.
- Denham, W. H. H. Specimens of minerals; from Missouri.
- Dennett, John, Lieutenant Revenue Marine Service. Insect from wood taken on board vessel at Mobile, Ala.
- Derby, Orville A. (See *Rio Janeiro, Brazil*.)
- De Vinne, Theodore L., New York. Duplicate set of cards illustrative of the process of overlaying in wood-cut printing.
- Devlin & Co., Astoria, Oreg. Samples of cans and labels used in packing "Columbia River fresh salmon."
- Dexter, Newton. Specimen of very small lobster; from Newport, R. I.
- Dibble, Henry, Chicago, Ill. Samples of encaustic floor tiling.
- Dilk, Fred. M. Bird skin; from Colorado.
- Dobbyn, John F. A living albino rat; from Washington, D. C.

- Dodge, R. I., Colonel, U. S. A.* Bead work cradles, bow, quiver and arrow, glass water-jar, double-headed tom-tom used by the Ute and south Cheyenne Indians.
- Dodge, W. W., & Co., San Francisco, Cal.* A kit of Alaskan codfish and half barrel of salmon bellies.
- Doron, Thomas S.* Specimens of owls; from Alabama.
- Dorsey, Rev. J. O. (through Dr. W. J. Hoffman).* Trappings of saddle belonging to "Big Bear," a chief of the Ponca Indians.
- Douglass, A. E.* Eight ceremonial weapons found in a mound in Volusia County, Florida, and three flat flint drills. (Lent for casting.)
- Dover, Thomas.* Specimen of cloth taken from a mound in Butler County, Ohio, and a stone pipe from Miami County, Ohio. (Lent for casting.)
- Dow, John M., Captain Pacific Mail Steamship Company.* Specimens of living plants, and a collection of fossils, stone celts, and 3 strings of green stone beads, etc.; from Central America.
- Dowell, John H.* Specimen of eel and flat-fish; from the Potomac River.
- Downey, Hon. S. W.* Samples of sulphate of soda and water; from Wyoming. (Sent for examination.)
- Downman, R. H.* Alcoholic specimen of deformed chick-turkey, from Warrenton, Va.
- Dufief, Lewis B.* A small living alligator; from Florida.
- Dugés, Dr. Don Alfredo.* Various contributions of shells (*Unio, Arion, Mytilus, etc.*); mammals (*Dasypus, Geomys, Canis, etc.*); fishes (*Clinostoma, Hudsonius, Carangus, etc.*); reptiles (*Crocodilus*), etc.; from various parts of Mexico.
- Dumont, W. B.* Two specimens of New York building stones.
- Dunbar's Sons, G. W., New Orleans, La.* Samples of cans and labels used for packing fish, etc.; also alcoholic specimens of shrimps, crabs, and crawfish; from the Mississippi River.
- Eagle Preserved Fish Company, Portland, Me.* Samples of cans and labels used in packing fish, etc.
- Eagle and Phoenix Manufacturing Company, Columbus, Ga.* Samples of manufactured cotton.
- Eagleson and De Veau, New York, N. Y.* Samples of Vermont marble tiling.
- Eastport Packing Company, Eastport, Me.* Samples of cans and labels used in the packing of fish, etc.
- Ebaugh, Daniel.* Specimens of quartzite and chlorite schist; from Maryland. (For examination.)
- Eddy, Irving L.* Picture-frame made from lava; from Tamarack Lake.
- Edwards, Frank A., Lieutenant U. S. A.* Buckskin "official" coat of the Columbia River (Washington Territory) Indians.
- Edwards, Thomas W.* Two specimens of Virginia building stones.
- Edwards, Vinal N.* Eight boxes of alcoholic specimens of fishes and marine invertebrates taken in Vineyard Sound and vicinity.

- Eisen, Gustave.* Box of fossils and alcoholic specimens of natural history; from California.
- Emerson, J. H.* Six pens made from quills of *Hyalinæcia artifex* taken off Martha's Vineyard, Mass.
- Evans, Gideon L.* Fragments of stone relics; from Iowa.
- Everman, B. W.* Four mortars and five pestles of stone; from Santa Paula, Cal.
- Fagan, Daniel.* Specimen of stalagmite marble; from Virginia.
- Fannee, Conrad.* Fresh specimen of black bass (*Micropterus salmoides*); from Four Mile Run, Va.
- Febiger, G. L., U. S. A.* Two catlinite pipes from Dakota, and a pipe from mound near Springfield, Ohio.
- Ferguson, T. B.* Specimen of shark (*Lamna cornubica*); from off Newport, R. I., and a green turtle from Chesapeake Bay.
- Fifth Avenue Hotel, New York.* Core of artesian well.
- Figgelmessy, Philip, United States Consul at Demerara.* A box of Indian relics and two specimens of iguana (*I. tuberculata*); from Demerara.
- Fillette, St. Julien.* A collection of Indian relics from North and South Carolinas, and minerals from Utah, California, and New York.
- Finch, C.* Two specimens of building stones; from Ohio.
- Fisher, A. F.* Human skull occupied by birds' nest; from New York.
- Fisher, A. L. & Co., New York.* Sample specimen of museum jars.
- Fisher, W. J.* Can of alcoholic specimens of natural history; from Alaska.
- Fletcher, J. A.* A "Fletcher" whale rocket gun and bomb. (Purchased.)
- Forbes, Dr. S. A. (through S. T. Walker).* Indian stone images; from mounds in Florida.
- "Forest and Stream" Publishing Company, New York.* A series of photo-engravings of noted sporting dogs.
- Forney, A. J., jr.* Young red fox (*Vulpes fulvus*); from Charles County, Maryland.
- Foster, J. B.* Stone pipe made from soapstone found at Chula, Va.
- Foster, William.* A large collection of building stones; from the States of California, Colorado, Nevada, Utah, and Wyoming.
- Fraser, Charles A.* Tank of alcoholic specimens collected by the late Professor Gabb, in the West Indies.
- Frierson, J. W. S.* Six specimens of Tennessee building stones.
- Fritsch, E., New York.* Samples of marble and slate tiles.
- Fuller, Andrew.* Specimens of rocks (Calcite, Lemonite, ect). (For examination.)
- Galvar Bros., New York.* Samples of ferruginous clay.
- Gannon & Flannery, Washington, D. C.* Samples of floor-tiling.
- Garetson, C. L.* Vial of water which fell during storm at Salem, Iowa, supposed to contain living animals.
- Garnier, Dr. John H.* Specimen of *Amblystoma*; from Ontario.



- Gatschet, Albert S.* Box of Indian stone implements ; from South Carolina.
- Gettinger, A.* Forty-eight specimens of Tennessee slates and building stones.
- Gecke, August.* Large stone maul and fragments of crania ; from Indian grave in Dakota.
- Gesner, William.* Box of fresh-water shells ; from the Catawba River, Alabama.
- Gibboney, William.* Box of stalactites ; from cave in Wythe County, Virginia.
- Gibbs, George J.* Eggs of lizard, box of bird's eggs, and deposit from salt pond ; from Turk's Island, British West Indies.
- Gilbert, Charles H.* Eleven boxes of fishes, fish products, etc ; from California and Mazatlan.
- Glasgow, Mo., Museum of Pritchett Institute.* Three casts of Indian relics ; from Missouri.
- Glazewell, Dr. Giles L.* Specimens of minerals and rocks ; from South Carolina.
- Gooding, Dr. W. W.* Specimen of snowy owl ; from the Arctic Ocean ; and a specimen of eagle (*Aquila canadensis*).
- Goode, F. C.* Specimens of katydid's eggs ; from Florida.
- Goodman, Mrs. E. T.* Mineral dust ; from Virginia. (For examination.)
- Goodrich, H.* Mineral substance which fell during thunder shower at McLeansboro, Ill., on April 11, 1881.
- Goodwin, W. H.* Specimens of kaolinite ; from Nelson County, Virginia.
- Gordon, Thomas H., (through A. K. Worthen.)* Specimen of iron pyrites ; from Virginia.
- Gorringe, H. H., Lieutenant Commander U. S. Navy.* Three specimens of building stones (granite, limestone, and syenite), taken from the Egyptian obelisk.
- Gregg, A.* Six specimens of Texas building stones.
- Grant, Charles C.* Small box of fossil plants.
- Greene, G. C.* Box of Indian implements ; from Oregon.
- Griffin, F. N.* Two arrow-heads ; from Sussex County, Virginia.
- Grigsby, C. S.* Spear and arrow-heads, leaf-shaped implements, celts, etc. ; from Tennessee.
- Grosvenor, Dale Company, Providence, R. I.* A collection of samples manufactured cotton goods.
- Guesde, L.* A collection of alcoholic specimens of reptiles, (*Liophis Dromicus*, *Anolis*, *Platydictylus*, *Iguana*, etc.), and four birds' skins (*Ceryle*, *Gallinula*, *Fielica*) ; from Guadeloupe, West Indies.
- Habersham, W. Hugh.* Scales of fish (*Promicrops guasa*) ; from Brunswick, Ga.
- Haldeman, Mrs. S. S.* Two boxes of Indian relics, duplicates from the collection of the late Prof. Haldeman.

- Hall, E. S.* Specimen of black bass, weighing five pounds, taken at the Great Falls, Potomac River.
- Hall, William E.* Three specimens of Montana building stones.
- Hamlin, William.* Two specimens of the diver (*Colymbus torquatus*).
- Hamlin, Dr. A. C.* Specimens of tin ore, etc.; from Maine.
- Hanks, Henry G.* Two casts of stone implements; from California.
- Hare, Dr. D. H.* Beech knot, 18 inches in diameter; from Highland County, Ohio.
- Harris, D. M.* Two stone relics; from Louisiana.
- Harrison, Dr. George B.* Specimen of chicken-hawk (*Accipiter Cooperi*).
- Haskins, C. H.* Two specimens of fish (*Hyodon*); from Wisconsin.
- Hatch, General, U. S. Army.* Three specimens of ore (Galena and Chrysocolla and Chalcocite); from New Mexico. (For examination.)
- Havre Museum, Havre, France.* A palæolithic flint hatchet; from France.
- Hawes, Dr. George W.* Specimen of granite (core of diamond drill); from New York; a specimen of soapstone from North Carolina, and five specimens of marble (Verte Campon, Leptanto, Lisbon, Mosaic, Egyptian).
- Hawley, E. H.* A living grass snake (*Cyclophis vernalis*); from Arlington, Va.
- Hawley, G. A.* Bronze ornament; from Gautemala.
- Hay, Dr. O. P.* Can of alcoholic specimens of fishes; from the Mississippi River.
- Hayden, Walton.* Jar of alcoholic specimens of fishes (*Uranidea*, *Stizostedium*, *Percopsis*, *Acipenser*), mole (*Condylura*), and mussel (*Unio*); from Hudson's Bay Territory.
- Hayes, W. I.* Living salamander (*Amblystoma*) and specimens of insects; from North Carolina.
- Hegman, S.* Box of minerals; from Tennessee. (For examination.)
- Hemphill, Henry.* A fine collection of Pacific coast mollusca.
- Hemphill, J. O.* Branch of oak, showing deposit of locusts' eggs.
- Henderson, Hon. J. G.* Twelve boxes of Indian relics taken from mounds near Naples, Illinois.
- Hendricks, G. Dix.* Box of Indian relics; from Preble County, Ohio.
- Henkle, Ambrose L.* Indian stone pipe and copper beads; from Fairfax County, Virginia.
- Henkle, Dr. S. P. C.* Cylindrical stone tube; from mound in Rockingham County, Virginia; also pipe of chlorite, from Shenandoah County, Virginia.
- Henshaw, H. W.* Specimen of albino squirrel. (Purchased in Washington market.)
- Hereford, Dr. T. P.* Arrow-point; from Missouri.
- Hering, Dr. C. J.* Nine packages of specimens of mammals, birds, shells, and insects, also fan used for blowing fire, and press for pressing the cassava roots for making into bread; from Surinam, South America.

- Hessel, Rudolph.* Specimen of pied-bill grebe (*Podilymbus podiceps*) and of young California salmon.
- Hetton, Bryant A.* Specimens of minerals; from Virginia.
- Hicks, George H.* Stone celt; from Michigan.
- Hill, James G., Supervising Architect United States Treasury Department.* Specimens of building-stones; from New Brunswick, Canada, and the States of Maine, Maryland, Nebraska, New Jersey, Rhode Island, and Texas.
- Hinckley, Isaac.* Four specimens of swans (*Olor columbianus*); from North Carolina.
- Hitchcock, C. H.* A large collection of building-stones and slates; from the States of Massachusetts, New York, New Hampshire, and Vermont.
- Hodges, H. C., Lieutenant-Colonel, U. S. Army.* Walking-stick made of wood from Washington Territory and with handle of deer horn.
- Holmes, W. H.* Three pieces of jasper from Yellowstone National Park, and arrow-heads, stone axes, etc., from the District of Columbia.
- Holub, Dr. Emil.* Box of minerals and fossils; from Africa.
- Hooper, C. L., Captain U. S. Revenue Marine Steamer "Corwin."* Box of Indian implements, skull of polar bear, human crania, etc.; from the Alaska Islands.
- Hopkins, L. H.* Three oyster knives.
- Horan, Henry.* Living ring-necked snake (*Diadophis punctatus*); from the District of Columbia.
- Houghton, J. H.* Samples of minerals; from Georgia. (For examination.)
- Howard, J. W.* Alcoholic specimen of alligator (*A. mississippiensis*).
- Howell, J. C., Rear-Admiral, U. S. Navy.* A carved marble tombstone; from plains of ancient Troy.
- Hufschmidt, R.* Two specimens of building-stones; from Iowa.
- Hughlett, Thomas.* Specimen of mud minnow (*Umbra pygmaea*); from Easton, Md.
- Huddleston, D. G.* Specimens of minerals; from West Virginia.
- Huddleston, George.* Samples of manufactured soap-stone and jar of powder; from Bethesda, Md.
- Hume, George W., Astoria, Oreg.* Samples of cans and labels used in packing fish.
- Hume, Thomas L.* Two specimens of mole (*Condylura cristata*) and an embryo calf (?) (hairy placenta?).
- Hunt, Dr. J. G.* Microscopic slide of cloth.
- Huntington, D. L., U. S. Army.* Two specimens of spiders; from Dakota Territory.
- Huntington, J. H.* A collection of building stones and slates; from the States of Delaware, Maryland, and Virginia.
- Huysman, Theodore.* Ax of Lydian stone; from United States of Colombia.

- Illinois State Library of Natural History, Normal, Ill.* Eighty-six species of Illinois fishes (in alcohol).
- Illinois State Historical Library (through A. K. Worthen).* Specimens of coal measure fossils; from Illinois.
- Ingersoll, Ernest.* Eight boxes of shells, Spanish and Indian pottery; from Florida; and samples of oyster-knives and hammer.
- Ipswich Mills, Ipswich, Mass.* Samples of hosiery.
- Irgans, Jorgen.* Box of Norwegian fishing tackle.
- Jackson, E. E.* Bottle of larvæ of insect; from South Carolina.
- Jackson, W. W.* Small box of quartz crystals, from Herkimer County, New York.
- Jaffords, L. G.* Specimens of land and fresh-water shells; from Minnesota.
- Japan, Government of (through Japanese Legation, Washington).* A series of samples of cotton, from the raw product to the manufactured goods.
- Javens, G.* Specimen of malformed catfish; (*Amiurus albidus*); from the Potomac River.
- Jeffords, E. A.* Two boxes of alligator and turtle eggs, birds eggs, etc.; from Florida.
- Jernigan, Silas.* Indian stone celt; from Florida.
- Jesuits' College, New Orleans, La.* Box of rocks, minerals, and fossils; from Louisiana.
- Jewett, James C.* Specimen of phosphate of iron and black sand.
- Johnson, Dr. H. N.* Small box of "Lucky stones" and petrified grain; from Wisconsin.
- Johnston, F. B.* Catlenite carving of human skull; from Campbell County, Kentucky.
- Johnston, George.* Specimens of potato bugs with parasites; from Elkton, Md.
- Johnston & Young.* Specimens of lobster shells, crabs, starfish, etc.
- Jones, Elliott.* Stone chippings and fragmentary pottery; from Arizona.
- Jones, R. L. & Co., Delta, Pa.* Twelve specimens of Maryland slate.
- Jones, Winslow.* Cans.
- Jordan, Prof. D. S.* A large collection of fishes from Utah and California, many of them new to science; also two tooth-picks, one ear-spoon and brush made by the California Chinese from seal bristles and silver.
- Jouy, P. L.* Specimens of mole and squirrel, from Virginia; and living specimens of *Amblystoma*, frogs, etc., from Oakland, Cal.
- Julien, Dr. A. A.* Specimen of building-stone; from France.
- Kane, Dennis.* Specimen of hematite; from New York.
- Kane, John J., Assistant Surgeon, U. S. Army.* Specimens of galena; from New Mexico.

- Keep, Captain (through Hon. James Bell).* Stone mortar and pestle; from a mound near Orange Lake, Florida.
- Kelly, Miss Anna W. (through Frank L. Donnelly).* Specimen of Italian greyhound (in flesh).
- Kelly, F. C.* Specimens of insects (*Diplax rubicunda*); from Dakota Territory.
- Kelly, L. L.* Three specimens of building-stones; from Iowa.
- Kelly, Thomas.* A collection of building-stones; from Ohio, Pennsylvania, and West Virginia.
- Kelly, W. W.* Two specimens of building-stones; from Vermont.
- Kendall, J. R.* Specimen of barnacle goose; from Jamaica Bay, Long Island.
- Keyley, W. S.* Specimen of iron pyrites; from Missouri.
- Kinney, Hon. O. P. (through John B. Wiggins).* Indian stone pipe; from New York.
- Kite, J. Allan, steamer "Fish Hawk."* Tank of alcoholic marine specimens and a living specimen of loon (*Colymbus glacialis*), also two eagles; from Avoca, N. C.; also a tank and 11 bottles of alcoholic specimens of fishes, taken by the steamer "Fish Hawk."
- Knickerbocker Ice Company, Philadelphia, Pa.* A wagon and models of all apparatus used in handling ice.
- Knickerbocker Millis.* Bulbous plant, and teeth of shark, and phosphate rock; from Florida.
- Knowles, G. A.* Two specimens of building-stones; from Iowa.
- Korte, Hon. Henry L.* Specimen of fish; from Ohio.
- Krebs, F. Eugene, Regensburg, Germany.* Framed exhibit showing the various processes in the manufacture of kid gloves, from the natural skin to the complete glove.
- Kresken, H. Acosta.* Alcoholic specimen of bird; from Ohio.
- Laidlow, James, & Co., Portland, Oreg.* Samples of cans and labels used in the packing of salmon.
- Lambert, N.* Four specimens of building-stones; from Washington Territory and Oregon.
- Lamborn, Robert H.* Three Indian relics; from near the sacred city of Testihuacan, Mexico.
- Lancaster Mills, Clinton, Mass.* Samples of manufactured cotton goods.
- Laney, Henry.* Alcoholic specimen of jumping mouse (*Zapus hudsonius*); from Maryland.
- Langhorne, Maurice.* Specimens of bat guano and of bark; from San Domingo, West Indies.
- Langston, Prof. J. M., United States Consul-General at Hayti.* Two boxes of fine corals, shells, etc.; from Hayti.
- Langman, Charles, Japanese Legation.* Specimen of Japanese cuttle-fish.
- Larco, Andrea, (through Prof. D. S. Jordan).* Tank of alcoholic specimens of fishes of California.

- Latham, M. R.* Specimens of minerals; from Virginia.
- Latkin, Joseph.* Three boxes of Indian relics, fossils, minerals, etc.; from Georgia.
- Lawrence & Co., Boston, Mass.* Samples of printed cotton shirting; from Cocheco Mills.
- Leach, J. P.* Specimen of duck; from Illinois.
- Leakin, George A.* Six specimens of Maryland building-stones.
- Le Baron, J. Francis.* One barrel two boxes of fossils, shells, etc.; from Florida.
- Lee, Joseph.* Two specimens of Texas building-stones.
- Leeper, W. H.* Four specimens of Oregon building-stones.
- Legare, J. Berwick.* Living dog, pointer.
- Legare, W. W.* Specimen of locust; from South Carolina.
- Lehman, A. E.* Two specimens of Pennsylvania building-stones.
- Leppelman, L.* Two pierced stone tablets, clay pipe, and flint; from Ohio.
- Leslie, C. C.* Tank of alcoholic specimens of fishes; from Charleston, S. C., markets.
- Leslie, James C.* Living garter snake (*Eutania sirtalis*); from Pennsylvania.
- Lewis, Prof. H. C.* Specimen of mineral (Philadelphiaite).
- Lewis, Mrs. P. M.* Two boxes of fossils, birds' skins, and plants; from Missouri.
- Lindsley, H. W.* Eighty specimens of building-stones; from Connecticut and New York.
- Livingston, Dr. I. A.* Specimens of shale and bituminous schists; from Arkansas.
- Long, Dr. O. M.* Walrus tusk and skull, from the Arctic Ocean; and jaw of shark, bill of sawfish, and can of alcoholic specimens of marine life; from Panama Bay.
- Lord, H. & G. W., Boston, Mass.* Sample of cod gill-net.
- Lord, W. Blair.* Six large specimens of native garnets and Indian iron spear-head and halibut hook; from Alaska.
- Love, W. L.* Specimen of insect; from North Carolina.
- Lucas, J. D.* Skull, Indian shell carvings, etc.; from mound in Fairfax County, Virginia.
- Luther, S. M.* Specimens of minerals and fragments of Indian pottery; from Ohio.
- Lyon, John.* Skin of deer (*Cervus virginianus*); from West Virginia.
- McAdams, William, jr.* Five casts of Indian pipe, one copper implement, and specimens of shells and minerals; from mounds in Illinois.
- McBride, R. W.* Box of Indian relics; from Indiana. (Lent for casting.)
- McBurney, George, and Son.* Living alligator. (*A. Mississippiensis*.)
- McCurdy, Alexander.* Five fishing knives, and galvanized iron swivel, used on trawl buoys by Gloucester fishermen.

- McDaniel, Joseph.* Specimen of mineral; from Tennessee.
- McDonald, Marshall.* Six boxes of specimens of fishes, reptiles, marine invertebrates, insects, etc.; from the Potomac River and Chesapeake Bay; also an Indian stone ax; from Virginia.
- McElwain, Robert.* One box of fossils and one box of fresh-water shells; from Pennsylvania.
- McEwin, J. B.* Limbs of oak tree, with deposit of locusts' eggs; from Tennessee.
- Macey & Co., Nashville, Tenn.* Eureka minnow trap.
- McFarlane, R.* Skins of Arctic hare, marmot, mink, beaver, etc.; from Fort Athabasca, Hudson's Bay Territory.
- Macfeely, R., Commissary-General of Subsistence, U. S. Army.* Specimens of insects taken from bacon, at Whipple Barracks, Arizona.
- Maine Red Granite Company, Calais, Me.* Two specimens of Maine building-stones.
- McGee, W. J.* A large collection of Iowa building-stones.
- McGraham, John T.* A button of metallic iron and piece of slag.
- Mackey, George W.* Two specimens of Pennsylvania slate.
- Mackney, C. E.* A specimen of decomposed mica schist and one of hornblende; from New York. (For examination.)
- McLean, John J.* Three boxes of Indian implements, ornaments, carvings, etc.; from Alaska.
- McMenamin & Co., Hampton, Va.* Samples of cans and labels used in packing fish, oysters, etc.
- McNeil, James.* Box of Indian relics; from Tennessee.
- Madsen, Peter (through Prof. D. S. Jordan).* Two cans of alcoholic specimens of fishes (*Catostomus fecundus*); from Utah.
- Maine Red Granite Company, Calais, Me.* Specimens of granite; from Red Beach, Me.
- Mallett, Dr. J. W.* Two boxes of minerals (Microlite, graphite, barcenite, etc.); from Virginia, Nevada, Mexico, and India.
- Maltby, C. S., Baltimore, Md.* Five samples of cans used in the packing of oysters.
- Manderson, A.* Nine specimens of Pennsylvania building-stones.
- Manderson, A.* Specimen of sandstone; from New Jersey.
- Mandeville, W.* Specimens of quartz; from Pennsylvania.
- Mangum, C. W.* Indian stone relic; from Fannin County, Georgia.
- Mann, C. E.* Two birds' skins (*Perissoglossa tigrina* and *Dendroica blackburniae*); from Illinois.
- Mansfield, I. E.* Eight barrels of fossil coal plants; from Beaver County, Pennsylvania.
- Marnock, G. W.* Specimens of reptiles (*Eumeces*, *Eutania*, and *Lytrodytes*); from Texas.
- Marsh, Prof. O. C.* Cast of bones of fossil bird (*Hesperornis regalis*, Marsh).
- Marsh, Philip.* Box of arrow and spear heads and a box of birds' eggs; from Illinois.

*Marshall, Edward.* Specimen of mineral dust; from North Carolina.  
(For examination.)

*Marsilliot, M. G., United States Revenue Steamer Corwin.* Specimen of ores; from Alaska.

*Martin, H. L.* Specimen of bug; from Illinois.

*Martin, S. J.* Two boxes of alcoholic specimens of fishes, crabs, etc., obtained by fishing vessels sailing from Gloucester, Mass.

*Mason, Prof. Otis T.* Specimen of quartz geode; from near Keokuk, Iowa.

*Massachusetts Cotton Mill, Lowell, Mass.* Samples of cotton cloth.

*Mather, Fred.* Alcoholic specimen of fish; from the Saint Lawrence River; also, living box-tortoise, marked "Yankee, 1862"; from Virginia.

*Mathews, W., Assistant Surgeon, U. S. Army.* Box of mineral substance used by Navajo Indians for bleaching silver and as a mordant in dyeing.

*Mathews, William H. C.* Samples of saline soda; from Mono Lake, California.

*Mattoni, C.* Six glass tubes for watering plants.

*Mayo, I. C., Gloucester, Mass.* Five samples of "Champion" row-locks.

*Medler, Lyman G. (through John B. Wiggins).* Fragments of fossil tusk of mastodon; from Tioga County, New York.

*Meigs, General M. C.* Specimens of Minnesota granite used by the Union Pacific Railroad in the construction of the railroad bridge at Bismarck, Dakota. Samples of building-stones; from the quarries on the military reservation at Fort Leavenworth, Kansas; specimen of pine wood, showing strength of the timber when rested at ends and weight placed in the center; also, specimen of Indian oolite; from the Ute Indian reservation.

*Merchant, Capt. George W.* "Purse" ring, such as were used on seines in 1854.

*Merrill, Dr. J. C., U. S. A.* Eggs of snow bunting (*Junco annectens*); from Montana.

*Meyers, P. H.* Specimens of mica schist and pyrite; from Maryland.

*Michigan Wire Shovel Co., Niles, Mich.* Wire scoop, for removing fish from nets.

*Miles Brothers & Co., New York.* Series of manufactured bristles, etc., exhibited at International Exhibition of 1876, Philadelphia.

*Miller, L. M.* Two fresh specimens of fish (*Amia calva*); from Geneva, New York.

*Miller, M. A.* Box of minerals and Indian arrow-heads; from Virginia.

*Miller & Coates, New York.* Samples of floor tiling.

*Miller, Joseph.* Specimens of minerals; from Arizona.

*Mills, A.* Two specimens of building-stones from Scotland and one from Germany.



- Miltimore, Capt. A. E., U. S. A.* Specimen of petrified mesquite wood and fossil tooth; from Texas.
- Missouri Fish Commission, Saint Louis, Mo.* Specimens of skip-jack (*Clupea chrysochloris*); from Lexington, Mo.
- Moore, Thomas (through C. F. Sawyer).* Shark's jaw; from Loggerhead Key, Florida.
- Moore, Dr. (through Hon. S. B. Maxey).* Samples of water; from Eureka Springs, Arkansas.
- Moran, George H., Surgeon, U. S. A.* Four boxes of Indian stone implements, etc. (arrow-heads, shell ornaments, ollas with burial remains, etc.); from Fort Thomas, Ariz., and North Carolina.
- Morgan, B.* Box of Indian relics; from Iowa. (Lent for casting.)
- Morgan, Edward.* Indian stone ax; from "Soapstone Hill", District Columbia.
- Morgan, Jaques J. M. de.* Collection of about a thousand specimens of European Tertiary and Cretaceous fossils.
- Morgan, Joseph (through Senator W. B. Allison).* Specimen of mineral; from Iowa. (For examination.)
- Morgan, Leonard.* Specimen of fossil; from Washington, D. C.
- Morgan, Thomas.* Two small boxes of shells; from New Jersey.
- Morris, L. S., & Son, Warsaw, N. Y.* Two specimens of building stones; from New York.
- Morton, Rush K.* Specimen of tree-toad (*Hyla versicolor*); from Chester County, Pennsylvania.
- Mott, F. J.* Specimen of siderite; from Colorado.
- Munroe, Prof. Charles E., U. S. Naval Academy.* Seventeen specimens of Maryland building-stones.
- Muth & Eckardt.* Two living fishes (*Macropodus* sp.); from Ohio.
- Myers, P. H.* Specimens of minerals; from Maryland. (For examination.)
- Myers, John.* Specimen of mineral; from Tennessee.
- Needham, George F.* Three hawks and one owl; from Maryland and District of Columbia.
- Nehrling, H.* Three specimens of birds' nests (*Milvulus*, *Chondestes*, *Cyanospiza*); from Texas.
- Nelson, E. W., U. S. Signal Service.* Thirty-six boxes and three barrels of specimens of general natural history, two lidaokas, two sleighs, and models of canoes and paddles; from Alaska.
- Nelson, Dr. Wilfred, British Consul, Panama.* Alcoholic specimen of snake; from forest in Ecuador.
- New Britain Knitting Company, New Britain, Conn.* Samples of knitted goods, underwear, etc.
- New Orleans, La., Jesuit's College.* Box of rocks, minerals, and fossils; from Louisiana.
- Newsome, David.* Samples of calcareous tufa; from Pierce County, Washington Territory.

- New York, N. Y., *American Museum of Natural History*. Seventeen boxes of the duplicate fossils of the James Hall collection. (First series.)
- Nichols, Dr. H. A. A. Tank of alcoholic specimens of fishes and a small box of birds' skins, from Dominica; also one fish-pot, from Antigua.
- Nichols, Henry E., *Lieutenant-Commander, U. S. Coast and Geodetic Survey steamer Hassler*. A collection in alcohol of specimens of fishes, from Alaska; and a bottle of sea soundings, from Menzie's Bay, Discovery Passage, British Columbia.
- Nixon, J. S. Worm cell with worm; from Pennsylvania.
- Noon, Luke. Two specimens of New York building-stones.
- Norris, P. W., *Superintendent of Yellowstone National Park*. Crate of mammal skins (*Ursus*, *Cariacus*, *Oervus*, and *Ovis*) and forty-seven boxes of minerals, rocks, natural formations, etc.; from the Yellowstone National Park.
- Norton, E. H. (through Senator F. M. Cockrell). Bottle of water; from Missouri. (For examination).
- O'Beirne, Col. James R. Specimen of fish (*Trichiurus lepturus*); from Long Island.
- Ober, F. A. Two copper axes; from Mexico, and two boxes of general natural history collections, from Kit's Island, etc., New Mexico.
- Oliver, John. Three specimens of Missouri building stones.
- Oliver, John A. Living snake (*Tropidonotus*); from the Potomac River, Washington, D. C.
- Oram, F. F. Sample of Titaniferous sand from the gold region of Randolph County, Alabama.
- Orcutt, Frank P. Nest of Canada jay (*Perisoreus canadensis*); from Maine.
- Oregon State Commission, *Permanent Exhibition Building, Philadelphia, Pa.* Exhibit made at Philadelphia, consisting of mounted specimens of birds and mammals, and agricultural products.
- Orton, Edward. A large collection of building-stones; from Indiana, Kentucky, and Ohio.
- Orvis, Charles F., *Manchester, Vt.* Six artificial flies for fishing.
- Owens, Charles S. A collection of old books, coins, badges, etc., also specimens of arrow-heads.
- Owsley, Dr. J. B. Indian stone pick and cone; from Ohio. (Lent for casting.)
- Packard, R. L. Box of fossiliferous rocks; from the Indian Territory.
- Page, Peter. Specimen of red-throated diver (*Colymbus septentrionalis*); from West Virginia.
- Page, W. F. Living water-snake (*Tropidonotus sipedon*); from Gunston's, Va.
- Palmer, Dr. E. Two boxes of mound relics; from Arkansas; and two boxes of general ethnologica; from Tennessee.
- Palmer, Miss Z. Two specimens of building-stones; from Ohio.
- Palmer, William. Specimen of snakes (*Tropidonotus*); from Virginia.

- Paris, France.* Museum of Natural History. Box of alcoholic specimens of natural history.
- Patrick, Jason.* Two specimens of building-stones; from Tennessee.
- Philadelphia, Pa., Academy of Natural Sciences.* Plaster casts of ants' nests. (Purchased).
- Phillips, Barnet.* Box of samples of the "Ogeeche lime."
- Peelor, David.* Fossil coal-print; from Pennsylvania.
- Pierson, A. R.* Specimen of bird; from New Jersey.
- Pilling, George P., Philadelphia, Pa.* Four silver-plated "Patent Cow-Milk-ers."
- Pinkham, Joseph.* Two specimens of minerals; from Virginia.
- Platt & Co., Baltimore, Md.* Two samples of cans used in packing oysters.
- Pocasset Manufacturing Company, Fall River, Mass.* Samples of manufactured cottons.
- Poey, Prof. Felipe.* Living boa-constrictor and box of insects; from Cuba.
- Polleys, Hon. W. H., United States Consul, Barbados, West Indies.* Specimens of shell celts and infusorial earths; from Barbados.
- Pollock, John S.* Indian arrow-head; from Hamilton County, Ohio.
- Porter, William H.* Specimen of butterfly.
- Portland Packing Company, Portland, Me.* Samples of cans used in packing fish, etc.
- Powell, Hon. Samuel.* Tank of alcoholic specimens of fishes, etc.; from Newport, R. I.
- Powell, S. W.* Specimens of worms infesting meadows at Madison, N. Y.
- Power, A. H.* A large, fresh specimen of salmon; from the Merrimac River, N. H.
- Powers & Weightman, manufacturing chemists, Philadelphia, Pa.* Seven boxes of chemical products and manufactures.
- Prentiss, J. C.* Specimen of "bog ore"; from near Ravenna, Ohio.
- Price, James.* Two specimens of building-stones from Tennessee.
- Prince, David.* Specimen of mineral; from New Jersey.
- Prince, S. F., & Co., South Dorset, Vt.* Two specimens of Vermont building-stones.
- Printz, Lorenzo.* Copper plates and disks; found in Fairfax County, Virginia.
- Pullen, Clarence.* Sixteen specimens of Kansas building-stones.
- Pybas, B.* Fossil; from Alabama.
- Quick, Edgar R.* Specimens of young moles (*Blarina brevicauda*); from Indiana.
- Quinn, James, Portland, Oreg.* Three samples of cans used in the packing of Columbia River salmon.
- Ramsey, N. A.* Specimens of plants; from North Carolina. (For identification).



- Ranchfuss, C. H., Jr.* Small box of pentramites; from Illinois.
- Rares, R. W. (through Mr. Eckhardt).* Eggs of carp (dead) and specimens of male eels; from Germany.
- Rau, Dr. Charles.* An Indian nut-stone and an animal-shaped clay figure (modern); made by the Tesuque Indians, of New Mexico.
- Rea, G. N.* Tin-type pictures of ball (weighing ten pounds) taken from stomach of cow; from Indiana.
- Rees, Richard.* Nineteen specimens of slate; from Maryland.
- Reid, George W.* Specimens of soapstone vessels, grooved axes, etc.; from Virginia; and a carved human face in chloride; from Pennsylvania.
- Ridgway, Audubon W.* Two specimens of bats; from Washington, D. C.
- Ridgway, Robert.* A large collection of skins of American birds (nearly 800 species and 2,500 specimens) and six boxes of specimens of snakes, turtles, and other reptiles, and a box of Indian relics (arrow-heads, pestles, mortars, etc.); from Indiana.
- Riggs, Thomas D.* Specimens of rocks; from Montgomery County, Md. (For examination.)
- Riley, T. E., U. S. A.* A small collection of plants; from Idaho.
- Rio Janeiro, Brazil, Museo Nacional (through Prof. Orville A. Derby).* Two boxes of fossils; from Brazil.
- Roberts, W. F.* A living specimen of *Phrynosoma*; from New Mexico.
- Robinson, C., Jr.* Two specimens of snakes (*Diadophis punctatus*); from Washington, D. C.
- Rogan, James W.* A specimen each of ant (*Mulilla coccinea*) and fossil; from Tennessee.
- Rogan, R. M.* Specimen of bug; from Tennessee. (For examination.)
- Rogers, D. M. (through Hon. J. C. Clements).* Specimen of ore; from Georgia. (For examination.)
- Roose, W. S.* Specimen, in flesh, of peacock.
- Ross, George W.* Two specimens of Tennessee building-stones.
- Roulet, F.* Stone knife and bird and boat-shaped implements; from New York. (Lent for casting.)
- Rowe, H. C., & Co., Fairhaven, Conn.* An oyster hammer, knife and opener.
- Ruby, Charles, U. S. A.* Skins and skulls of wild cat, swift, antelopes, deer, coyotes; antlers, lower jaw, and skin of elk; three specimens of ambeystomas, a box of birds' skins, nests, and eggs, and bottle of micaceous sand; from Wyoming.
- Runyan, J. C.* Specimens of minerals; from Washington Territory.
- Rusby, Henry H.* Twelve boxes of plants, box of fragmentary pottery, bones, etc., and pair of sandals from cave, stone ax, an Indian carved stick, and specimens of birds' skins; from New Mexico.
- Ruth, John A.* Box of Indian stone implements; from Bucks County, Pennsylvania.

- Salsbury, H. S.* Six specimens of fossils (casts); from Wisconsin.
- Sampson, F. A.* Fifty-four specimens of cretaceous fossils; from Texas. (For identification.)
- San Francisco Cal., State, Mining Bureau.* Cast of Indian stone hook; from California.
- Sankey, R. A.* Specimens of pyrrhotite; from Colorado. (For examination.)
- Schieffelin, W. H. & Co., New York.* A large collection of native and manufactured chemical products.
- Schneck, Dr. J.* Four living specimens of turtles (*Aspionectes* and *Malacoclemmys*); from Illinois.
- Scotchler & Gibbs, San Francisco, Cal.* Samples of cans and labels used in the packing of Columbia River salmon.
- Schooner Northern Eagle (through S. J. Martin).* Fresh specimen of sturgeon; from Ipswich Bay, Massachusetts.
- Scott, Dr. J. M.* Specimen of bat (*Atalapha cinereus*); from Virginia.
- Scribner's, Charles, Sons, New York.* The "Game Fishes of North America," by G. Brown Goode and S. A. Kilbourne. (Illustrated with colored plates.)
- Selkirk, J. H.* Specimens of menhaden (*Brevoortia patronus*); from Texas.
- Serrent, Samuel S.* Box of minerals; from Virginia.
- Seve, Edward, consul of Belgium, Philadelphia, Pa.* Specimen of green coffee; from Yungas Valley, Bolivia.
- Severance, W. N.* Section of larch (Tamarack) with fire-scar; 26 feet below surface, at Olivia, Minn.
- Shaler, Prof. N. S.* A large collection of building stones and slates; from Maine, Massachusetts, and Rhode Island.
- Shaw, James.* Human skeleton taken from mound near Savanna, Illinois.
- Sheldon, Prof. D. S.* Specimens of parasites taken from the gills and intestines of sturgeon, and two living serpents; from Iowa.
- Shenandoah Valley Railroad Company, Luray, Va.* Four specimens of marble; from Luray, Va.
- Shepard, Prof. Charles U.* Ten specimens of minerals; from various localities.
- Shepard, Prof. C. U.* Specimen of pagodite; from Georgia.
- Shepard, N. B.* Specimen of hematite ore; from Buckingham County, Virginia.
- Sherman, General W. T.* Shield, flag, and crape used to drape the catafalque of President Garfield, at Cleveland, Ohio, September 26 1881.
- Sherwood, G. P.* Three specimens of New Brunswick, Canada, igneous stones.
- Shields, George O. (through Dr. J. W. Velie).* Three small gyrosomus taken from stomach of pike caught in Louisiana.

*Shindler, A. Zeno.* Alcoholic specimen of horned toad (*Phrynosoma cornutum*).

*Shoemaker, George.* Four living snakes (*Tropidonotus sipedon*); a bottle of alcoholic specimens of reptiles, and a collection of birds' nests and eggs; from the District of Columbia.

*Shufeldt, Dr. E. W., U. S. A.* Box of insects from Fort Laramie, Wyoming; alcoholic specimen of serpent, from the Isthmus of Darien; four eggs of tortoise (*Cistudo clausa*) from Connecticut, and a collection of 34 species of bird's eggs.

*Silver Lake Company, Wellington Bros. & Co., agents, Boston, Mass.* Twenty-nine samples of cordage.

*Simmons, Dr. C. A.* Five specimens of building stones; from Florida.

*Simpson, Friench.* Box of fossil bones; from Colorado County, Texas.

*Sisson, H. & Son, Baltimore, Md.* Specimen of building stones; from France.

*Skinner, Josiah.* Four jars of alcoholic specimens of fishes (*Dorysoma*, *Stizostedium*, *Hyodon*, *Clupea*, *Catostomus*, &c.); from Alabama.

*Small, G. W.* Specimen of flesh of porpoise; from Provincetown, Mass.

*Smith, A. W.* A living specimen of milk snake (*Ophibolus doliatatus*); from Maryland.

*Smith, Courtland A.* Four specimens of rocks; from Prince William County, Virginia.

*Smith, George P.* Cocoon of moth.

*Smith, Prof. Hamilton L.* Box of microscopic slides of infusoria.

*Smith, Horace J.* Samples of dried abalone meat; from Santa Barbara, Cal.

*Smith, John P.* Box of stone implements, &c.; from Maryland.

*Smith, Miss Rosa.* A collection of fishes; from San Diego, Cal.

*Smith, S. W.* Box of minerals; from Pennsylvania. (For examination.)

*Smock, J. C.* Ninety specimens of building stones from New York and New Jersey.

*Smythe, George.* Two boxes of coal; from the coal measures of Illinois.

*Snow, A. L.* Specimen of clay impregnated with calcite; from Tennessee. (For examination.)

*Snowden, Fred.* Two specimens of flying squirrels (*Sciuropterus volucella*); from Virginia.

*Snyder, E. S.* Thirteen specimens of building stones; from West Virginia.

*Sperr, F. W.* Fifty specimens of building stones; from Massachusetts, New Jersey, and Pennsylvania, and one from France.

*Sperry, E. A.* Specimen of orthoclase, actinolite, &c.; from Colorado. (For examination.)

*Spray, S. J.* Specimen each of skunk and bird; from Colorado.

- Spring, E. C.* Three specimens of ores; from Virginia. (For examination.)
- Springfield Soapstone Company, Springfield, Mass.* Two specimens of soapstone; from Vermont.
- Stanley, Henry O.* A specimen of young land-locked salmon; from the Androscoggin River, Maine.
- Stearns, Silas.* Three specimens of apparatus' used in the Red Snapper fishery, of Florida, and a bottle of colored sea water; from Pensacola Bay.
- Steele, J. G.* Specimens of polished stone; from Lexington, Va.
- Stevenson, James.* Five specimens of building stones; from New Mexico. See, also, Washington, Smithsonian Institution, Bureau of Ethnology.
- Stewart, J. T.* Stone-ax; from——
- Stewart, C. A.* Specimen of bat; from Washington, D. C.
- Stewart, M., & Co., Milwaukee, Wis. (through E. G. Blackford).* Specimen of white-fish, (*Coregonus clupeiformis*), weighing, when dressed, 11½ lbs.; from Lake Michigan.
- Stilwell, G. M.* Specimen of salmon; from the Penobscot River, Maine.
- Stons, Livingston.* Three boxes of alcoholic specimens of fishes, from the McCloud river, Cal.; specimens of snakes and lizards, box of geological specimens, box of birds' nests and eggs, three boxes of fossils, skin of young bear, and teeth and bones from Bear Cave; all from California.
- Stufflebeam, J. G.* Specimens of pyrites; from Madison County, Arkansas. (For examination.)
- Stuart, W. E.* Specimens of young shad (*Clupea sapidissima*); from the Potomac River.
- Sturtevant & Cole., Bethel, Vt.* Two specimens of building stones; from Vermont.
- Swan, Judge J. G.* Two boxes of alcoholic specimens of fishes (*Oncorhynchus*, *Sebastichthys*, *Hippoglossus*, *Salmo*, etc.); from Washington Territory, and specimens of salted fish ("Beshowe"); from Victoria.
- Taylor, E. L.* Specimen of hybrid fowl; from Virginia.
- Taylor, Thomas.* Three fossils; Maryland and North Carolina.
- Taylor, William J.* Six living terrapins and a box of mound remains; from Georgia.
- Tennessee Cotton Factory, Nashville, Tenn.* Samples of cotton cloth.
- Tennessee River Marble Company, Knoxville, Tenn.* Two specimens of building stones; from Tennessee.
- Texas, Legislature of, Austin, Tex.* Thirty specimens of building stones; from Texas.
- Thews, William.* Two specimens of building stones; from Idaho.
- Thomas, A. D.* Indian stone image (broken); from Hancock County, Illinois.

- Thompson, Professor.* Silicified lower jaw of bison; from Veta Pass, Colorado.
- Thompson, Capt. William (through J. W. Collins).* Piece of sword-fish snout, broken off in fishing schooner; from Gloucester, Mass.
- Thomson, John H.* Specimens of ore; from New Mexico. (For examination.)
- Thomson, W. J. R.* Specimens of embryonic centipede; from Texas.
- Thurber, H. K. & F. B., & Co., New York, N. Y.* Samples of labels and cans used in packing fish, oysters, etc.
- Tichkematse (Indian).* Indian head-dress and shield of the Cheyenne Indians.
- Todd, Prof. J. E.* Collection of Carboniferous fossils; from Iowa and Nebraska.
- Tokio, Japan, University of (through Peabody Museum, Cambridge, Mass.)* Box of fragmentary Japanese pottery.
- Toner, Dr. J. M.* Piece of roofing and tiling taken from excavated Roman villa at Morton, near Brading, Isle of Wight.
- Tongue, George H.* Small box of birds' eggs; from Warrenton, Va.
- Town, Matthew, Great Inagua, W. I.* Three eggs of Flamingo.
- Townsend, T. B.* Specimen of Ohio building stone.
- Trowbridge, S. H.* Box of Indian implements (lent for inspection) and box of fossils; from Missouri.
- Trumbull, Eli.* Specimens of rocks; from Huron County, Ohio. (For examination.)
- Truzevant, George S.* Specimens of fossils from the phosphate beds of South Carolina.
- Tufts, James W.* Specimen each of Italian and New York marble.
- Turner, Lucien M., Signal Service, U. S. A.* Six boxes of general, natural history and ethnological specimens, from Alaska; and two boxes of birds' skins, and a tank of alcoholic specimens of fishes, etc.; from Illinois.
- Underwood, William, & Co., Boston, Mass.* Samples of cans, packages, and labels used in the packing of fish, etc.
- United States Stamping Company, New York.* Box of samples of stamped tin-ware.
- Valentine, G.* Box of minerals; from Great Bend, Pa.
- Vannoy, J. C.* Specimen of minerals (Smithsonite, Limonite, Siliceous sinter, etc.); from Virginia. (For examination.)
- Vanoy, Elijah.* Specimen of ore; from Tennessee. (For examination.)
- Velič, Dr. J. W.* Collection of fishes, in alcohol; from Florida.
- Vermillion, John.* Specimen of malformed sweet potato; from Virginia.
- Very, Samuel W., Lieutenant, U. S. N.* A cassock or water-proof coat, made of the skin of the hair-seal at Nain, Labrador, a mission station of the Moravian Brotherhood.
- Vetromite, Rev. Eugene.* Specimens of Italian shells.
- Wachmuth, Charles.* Nine specimens of building stones; from Iowa.



*Wade, Lieut. E. C., U. S. Revenue Marine Steamer Moccasin.* Two fossil shark's teeth and pieces of fossil vertebræ.

*Wagner, Henry.* Specimen of moth; from Washington, D. C.

*Walke, E. H.* Specimen of shad, weighing seven pounds, and specimens of lamprey eels (*Petromyzon marinus*); from Albemarle Sound.

*Walker, S. T.* Twelve packages, containing specimens of general natural history (reptiles, mammals, fishes, birds, insects, etc.), Indian implements, mound remains, etc.; from Florida.

*Wallace, John.* A mounted specimen of rail (*Porzana carolina*).

*Wallem, Frederick M.* Two alcoholic specimens of trout, with parasites; from Norway.

*Ware, James.* Four Indian stone relics; from Indiana.

*Warner, J. S.* Box of fossils and Indian implements; from Tennessee.

*Warner, W. B., & Co., Philadelphia, Pa.* Bottle containing specimens of Irglervin.

*Washington, D. C. :*

*Anthropological Society.* Box of arrow-heads, spear-points, etc.

*Department of State.* (See under names of *United States Consuls, Philip Figyelmesy and W. H. Polleys.*)

*Treasury Department :*

*Revenue Marine Division.* (See under names of *Capt. C. L. Hooper, Lieut. John Dennett, M. G. Marsilliot, and E. C. Wade.*)

*United States Coast and Geodetic Survey, Prof. J. E. Hilgard, Superintendent.* (See under names of *Lieut. Commander Henry E. Nichols, Marcus Baker, O. H. Boyd, Gershon Bradford, and W. H. Dall.*)

*War Department :*

*Medical Department.* (See under names of *Doctors Elliott Coues, G. W. Matthews, R. W. Shufeldt, H. C. Yarrow, and Timothy E. Wilcox, and Hospital Steward Charles Ruby.*)

*Pay Department.* (See under name of *Col. George L. Febiger.*)

*Quartermaster's Department.* (See under name of *General M. C. Meigs.*)

*Signal Service, U. S. A.* A collection of alcoholic specimens of fishes, crabs, star-fishes, etc.; from Greenland. (Sent by Dr. Pavy to Capt. H. W. Howgate.) Also skin of bear; from Arctic America. (See also under names of *Sergeants E. W. Nelson and L. M. Turner.*)

*Subsistence Department.* (See under name of *General Robert Macfeely.*)

*United States Army.* (See under names of *Generals W. T. Sherman, and Hatch, Colonels Dodge and Hodges, Captains Charles Bendire, A. E. Miltimore, D. L. Huntington.*)

*Navy Department :*

*Bureau of Medicine and Surgery.* (See under names of *Doctors John F. Bransford, F. C. Dale.*)

**Navy Department—Continued.**

**Bureau of Navigation** (Commodore W. D. Whiting, Chief of Bureau). Specimens of ocean bottom taken by U. S. S. *Ranger*, Commander J. W. Phillips, commanding, between San Diego, Cal., and latitude 34° N., longitude 137° W.

**Bureau of Provisions and Clothing.** (See under names of Paymaster A. W. Bacon, U. S. N. See under names of Capt. L. A. Beardslee, Commander H. H. Gorringe, Lieut. Commander Henry E. Nichols Lieut. Samuel W. Very, and Master A. E. Babcock.)

**Bureau of Steam Engineering.** (See under name of Chief Engineer W. B. Brooks.)

**United States Naval Academy.** (See under name of Prof. Charles E. Munroe.)

**United States Naval Observatory.** Manuscript of Capt. Charles F. Hall relating to his voyages and explorations in Arctic America.

**Interior Department :**

**Bureau of Ethnology** (J. W. Powell, Director). Fifty-five packages of general collections of ethnology from Pueblo villages in New Mexico, collected by James Stevenson, F. H. Cushing, H. J. Biddle, and others. (See also under names of R. L. Packard and James Stevenson.)

**United States Fish Commission.** (Prof. Spencer F. Baird, Commissioner.) Ninety-two boxes of general marine and other collections obtained by the steamers Fish Hawk and Lookout and assistants along the Atlantic sea-board. (See also under names of H. C. Chester, A. H. Clark, J. W. Collins, T. H. Bean, George G. Davenport, V. N. Edwards, Charles H. Gilbert, Ernest Ingersoll, D. S. Jordan, J. A. Kite, M. McDonald, S. J. Martin, W. F. Page, L. Stone, Thomas Taylor, E. H. Walke, and W. A. Wilcox.)

**United States Geological Survey** (J. W. Powell, Director). Twenty-seven boxes of fossils collected by Prof. L. F. Ward in Colorado.

**Waters, Pierre.** Two bones from drum-fish (*Haploidonotus grunniens*); from Washington.

**Weaver & Corderoy.** Box of clay, slate, and stone pipe; from Indiana.

**Wellington Brothers & Co., Boston, Mass.** Box of samples of cordage.

**Wells, J. E.** Specimen of insect (*Gryllotalpa borealis*); from Ohio. (For examination.)

**Wells, J. G.** Three boxes of birds' skins; from Grenada, West Indies.

**West, John, Westport, Oreg.** Samples of cans and labels used in packing Columbia River salmon.

**West, John.** Weapon of bill-fish taken from the bottom of the brig "Meteor" of Alexandria, while on a voyage to Brazil in 1876.

**Wharton, Joseph.** Specimen of pure tin; from Corneto, State of Durango, Mexico.

- Wheeler, Charles Le Roy.* Specimen of oolitic flint, and a fresh specimen of gravid porpoise (*Phocaena lineata*) found on beach at Cape May, N. J.
- White, Dr. C. A.* Block of Indian pipe-clay, from S. W. Minnesota; a box of fossils, from Colorado; the type of *Zygorobus Whitei*; a small box of arrow-points, and a specimen of Triassic sandstone (core of diamond drill); from Colorado.
- White, C. W.* A string of beads from the burial ground of the Waco (Texas) Indians.
- White, G. W. (through Hon. H. D. Money.)* Specimen of ore from Mississippi. (For examination.)
- White, Dr. J. A.* About 500 arrow points from Oregon. (Purchased.)
- Whitfield, R. P.* Box of fossils; from the Black Hills, Dakota.
- Wiggins, John B.* Eight boxes of Indian stone relics, mound remains, &c., from New York and Virginia, and specimens of an insect (*Tremex columbae*); destructive to maple trees, at Waverly, N. Y.
- Wilcox, Joseph.* Four specimens of arrow-heads; from Hernando County, Florida.
- Wilcox, Dr. Timothy E., U. S. A.* Specimens of unios from Boise River, Idaho, and a skin of (*Lanius borealis*); from Idaho.
- Wilcox, W. A.* Three specimens of cusk (*Brosmius brosme*), from Boston markets, and a tumor taken from a salted cod-fish.
- Wilkesbarre, Pa., Natural History and Geological Society of.* Specimens of black muck.
- Wilkinson, E., Jr.* A collection of marine shells; from Lower California. (For examination.)
- Williams, J. F.* A small quartz crystal; from mountains, Pennsylvania.
- Williams, J. M.* Deformed lobster claw; from Ellsworth, Me.
- Williamson, W. A.* four vials, containing specimens of young sponges, fishes, insects, and worms, and two boxes of insects and shells; from Canada.
- Willson, W. L., Philadelphia, Pa.* Samples of encaustic floor tiles.
- Willson, J. H.* Two specimens of minerals; from Virginia. (For examination.)
- Wingate, J. D.* Living-horned toad (*Phrynosoma*); from Pennsylvania.
- Winchell, N. H.* A large collection of specimens of building stones and slates; from Dakota and Minnesota.
- Winthrop, L. A.* Pharyngeal bone of fresh-water drum (*Haploidonotus grunniens*); from Minnesota.
- Wittfield, William.* A box, containing alcoholic specimens of reptiles, fishes, insects, and shells; from Florida.
- Wolff, J. E.* A large collection of specimens of building stones from Maine, Massachusetts, and Rhode Island.

Woodman, Dr. H. T. Indian figure (frog) pipe (purchased) and a pipe of black stone and a partially drilled banner stone; from Indiana.

Wooster, A. F. Box of birds' eggs; from Connecticut.

Worth, S. G. Four specimens of land-locked salmon; from North Carolina.

Wright, Abel C. Five specimens of fishes; from Georgia.

Wright, B. H. Box of fossils; from New York.

Wright, James. Two specimens of building stones; from Tennessee.

Wright, L. A. A living centipede and horned-frog; from Texas.

Wynn, Rev. L. B. Small box of minerals; from Virginia. (For examination.)

Yarrow, Dr. H. C. Seven alcoholic specimens of reptiles (*Opheosaurus*, *Cyclophis*, *Alligator*, etc.); from Fort Macon, N. C.

Yarrow, John. Two bottles of alcoholic specimens of insects.

Yeates, W. S. Specimens of fossil sharks' teeth; from North Carolina.

Zeledon, José C. A small collection of birds' skins; from Costa Rica.

Unknown. Box of building stones; specimen of haddock; specimen of fish; from Canada. Box of minerals; from New Hampshire. Living snake (*Diadophis punctatus*); from the District of Columbia. Specimen of butterfly; samples of "dried" cider and milk.



## REPORT OF THE CHEMIST.

FRED. W. TAYLOR.

The chemist was occupied during the first part of the year in making a partial catalogue and in overhauling that part of the collection of minerals and rocks at that time stored in the Smithsonian building, and in making some partial disposal of the duplicates, packing them in sets for distribution and arranging them so that they could be found.

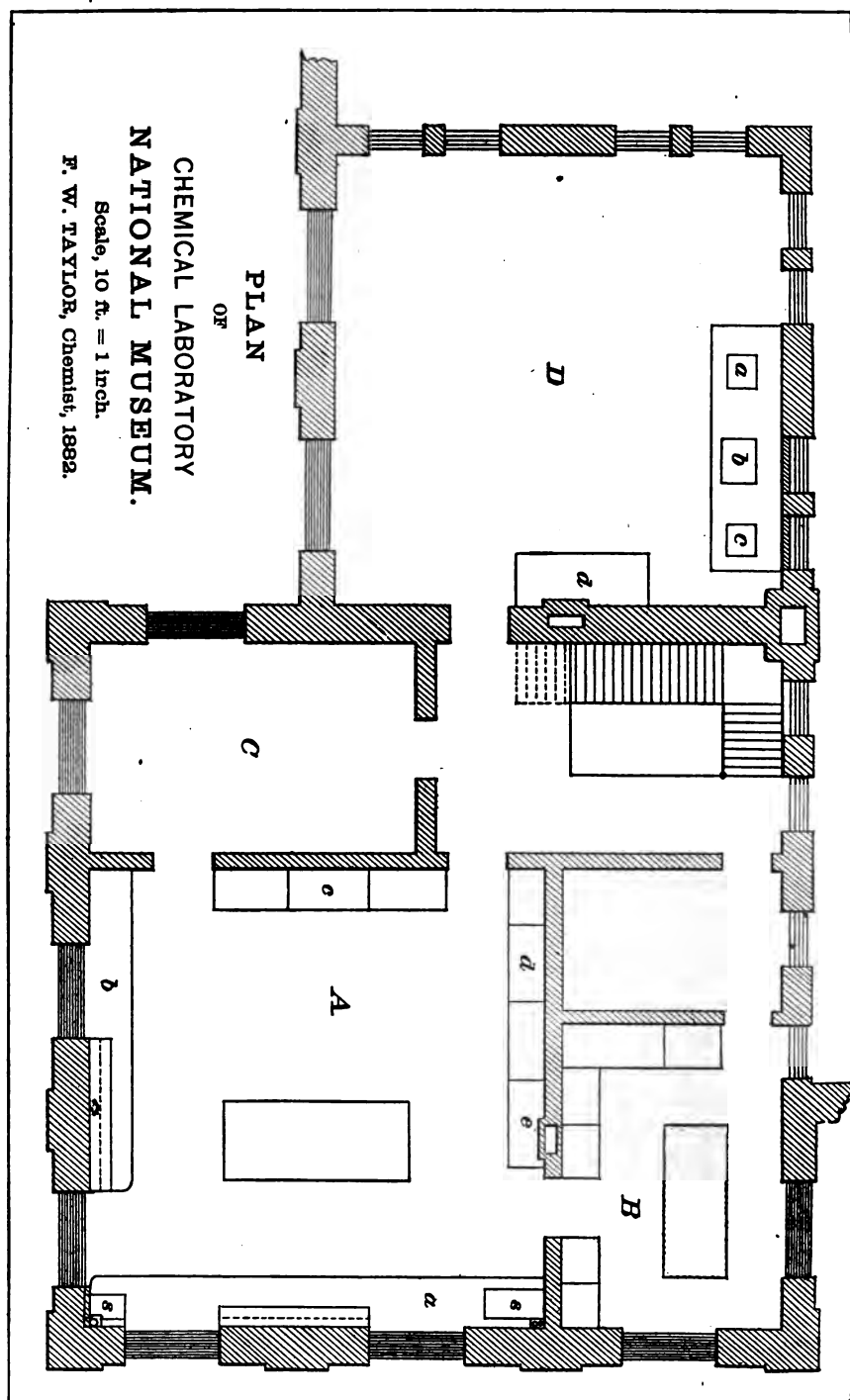
Preparations for the removal to new quarters and plans for a new laboratory soon however consumed all the available time, and later he was engaged in the removal of the laboratory from the Smithsonian building to that of the National Museum. Unfortunately, this occurred about the middle of February, when every one was busily occupied in making preparations for the coming inauguration and the festivities which followed this event. Much time was lost, and it was not until April following that the laboratory was ready for work. Perhaps a brief description of the present quarters, with their location and equipment, would not be out of place.

The new laboratory is located in the southwest corner of the new Museum building, in what is called the Southwest Pavilion, and occupies the entire second floor of the same. The rooms on the second floor are four in number—the laboratory proper, 25 feet square; the balance room, 12 by 16 feet, and the office, a small room, similar in size to the balance room; the fourth room is in what is called the annex, on the same floor, and has been fitted up as an assay room.

The laboratory, A, is a large well-lighted room, and, as already stated, 25 feet square. It is fitted with two wall desks, *a* and *b*, placed against the south and west walls. These desks are of white pine throughout, 3 feet high and 2 feet wide, divided below into drawers and lockers. Above is placed the usual rack for re-agents, and above that a case filling the space above to the ceiling. The north wall is occupied by a long wall case, *c*, divided into three compartments, and used for chemicals and apparatus; the east wall is occupied by a similar case, *d*, and the acid or fume chamber, *e*.

The south wall desk has two large sinks, *ss*, one at each end; and in the southwest corner are placed two Bunsen pumps. These are connected with the desks, and so arranged that each desk has three points of connection. East of the laboratory we have the balance room, B; this room has been very handsomely fitted up with wall cases of black walnut, occupying the west and north walls. These cases fill the entire space from floor to ceiling, the lower part being divided into drawers. All choice apparatus, platinum, graduated glassware, and extra glassware is kept in this room.

The balances are five in number—a large analytical, carrying one kilogramme; one medium size analytical, to carry two hundred grammes;



one of Becker's small prescription balances, to carry one hundred grammes and turn with one milligramme (this balance is exceedingly handy for proximate weighings, fluxes, &c.); one pulp scale, for weighing out assay charges, with a set of Chandler's assay ton weights; and one assay balance for buttons, showing one one-hundredth of a milligramme. All of the balances are Becker & Son's make. In addition to the above, the laboratory also possesses one Jolly's balance, for specific gravity determination.

North of the laboratory, and separated from it by a hall-way, is the assay room, D. The permanent fittings here are, first, one small Hibb's furnace, *a*, with a 4 by 10 inch muffle; a large Battersea muffle furnace, *b*, with a 6 by 14 inch muffle, and a crucible furnace, *c*.

In addition to the assay furnace, the room also contains the apparatus for furnishing distilled water and a large sand bath, *d*. It is the desire of the chemist and the intention of the Director of the Museum to add to the equipment some form of crusher, probably one of Blake's excellent laboratory crushers, and if possible some kind of a grinding machine; these will if possible be driven by steam power, supplied from the engine-room.

On the third floor is a large room the full size of the pavilion, as it is called, about 37 feet square, at present used only as a storage room. It is the intention of the Director to fit up this room as a qualitative laboratory. The work of the Institution consists at present largely in the qualitative examination and determination of minerals and ores, received from almost every part of the United States, and often wrongly named, if named at all, by the collectors. It is often very inconvenient to carry on work of that kind in a room where quantitative work is in progress, and this room, when fitted up, might also be used as a laboratory for special research.

It will be seen that with one or two exceptions the laboratory is pretty well fitted up and equipped for two chemists; the supply of glass and porcelain ware is amply sufficient; one of the exceptions is in the platinum ware and another in the lack of another analytical balance. There are however two reasons for this defect; one the lack of any definite appropriation for fitting up a laboratory, and, second, the fact that the Superintendent of the Tenth Census has signified his intention to deposit the platinum ware and balances of the Newport laboratory in the Museum, to be used in any work connected with the Census, as the only work done besides the routine work of the Institution is done in connection with the Census of the building stones of the United States. This seems eminently proper, and this addition will supply all the existing deficiencies, giving the laboratory an especially large and valuable supply of platinum ware. The only fault that can be found with the present quarters is the insufficiency of means for proper ventilation; the fume chamber is not large enough, and the flue used is hardly large enough to exhaust it properly. Unfortunately, this is a case that is hard



to remedy. The ceiling is perhaps a little low, but if the ventilation was better that would matter but little.

In regard to the work done little can be said; it is of so varied a nature that hardly any two analyses can be connected to draw any conclusions from or establish any facts.

When the collections of the Museum are fully identified and arranged there will be time for scientific work and investigation: subjects are abundant, and as a repository for the Geological Survey, the Department of the Interior, &c., the Museum must some day possess the largest and most complete collection of the minerals, ores, and rocks of America, and of the world, that has ever been collected together in any one museum.

The work done for the Institution by the chemist has been the identification of numerous specimens sent in from different localities, analyses and assays of various ores, iron, gold, silver, &c., which have been undertaken whenever it was thought they might aid in developing the mineral resources of the country. The chemist has received specimens of gold and silver ores for examination, some showing the precious metals, others devoid of even a trace; one interesting specimen was received, said to be from New Mexico; the specimen was arsenical pyrite; the piece was completely filled with small nuggets of gold from the size of a pin point up to the size of an ordinary pin head; the nuggets were not pure gold, but alloyed with a little silver; the assay gave a value of nearly thirty thousand dollars to the ton.

In iron ores the same variation has been found, some few being of value, while others have been worthless; copper ores, most as carbonate, with some little native copper, have not been wanting. Lead, in the form of galena, has also been received, generally as silver ore, though most of it has proved of little value except as a source of lead. Tin ore has also been received, though unfortunately the specimens contained no tin; one interesting specimen of this kind presented to the chemist with the assurance that it contained eight per cent. of tin consisted of a mass of small crystals of tourmaline.

Among the analyses made may be mentioned one of a sample of water from the Eureka Springs, Arkansas. The sample was shipped and received during very warm weather, and was entirely devoid of any contained gases. The analysis shows only the comparatively small quantity of solid constituents contained in the water—8.81 grains to the gallon of 231 cubic inches.

Among the few specimens of interest received may be mentioned three small samples from the excavation for a new court-house at Scranton, Pa., one of the peat, one of the black muck, and another of the jelly like substance so well described by Professor Lewis, of the Academy of Natural Sciences of Philadelphia, under the title of "A jelly-like substance resembling Dopplerite." The samples received by the chemist contained 87 per cent. of water, 6.86 of volatile matter, 3.52 of fixed carbon, and 2.47 ash.

The chemist is now engaged in making analyses of a number of samples of the galvanized iron wire used by the Signal Bureau of the War Department. It is impossible to say anything in regard to these analyses without going into details that would be of little interest in this part of the report. The object is believed to be to aid an attempt to establish some relation between the chemical composition of the wire and its power of conduction.

The laboratory work done by the chemist has been in answer to letters referred to him by the Secretary, as follows: Twenty-six assays, involving twenty-nine determinations; thirty-one quantitative analyses, involving one hundred and seventy-four determinations, and thirty-two qualitative reports, identifying seventy-nine specimens; also a report on the specific gravity of a number of specimens of Jadeite from South America; he has also prepared answers to numerous letters received by the Institution in reference to chemical subjects.



# REPORT OF THE EXECUTIVE COMMITTEE OF THE BOARD OF REGENTS OF THE SMITHSONIAN INSTITUTION FOR THE YEAR 1881.

The Executive Committee of the Board of Regents of the Smithsonian Institution respectfully submit the following report in relation to the funds of the Institution, the appropriations by Congress for the National Museum and other purposes, the receipts and expenditures for both the Institution and the Museum for 1881, and the estimates for the year 1882:

## *Condition of the funds January 1, 1882.*

The amount originally received as the bequest of James Smithson, deposited in the Treasury of the United States in accordance with the act of Congress of August 10, 1846.....	\$515,169 00
Residuary legacy of Smithson added to the fund by act of Congress, February 8, 1867.....	26,210 63
Additions to the fund, from sayings, &c., by act of Con- gress, February 8, 1867 .....	108,620 37
Bequest of James Hamilton, of Pennsylvania, 1874.....	1,000 00
Bequest of Dr. Simeon Habel, of New York, 1880.....	500 00
Proceeds of sale of Virginia bonds, 1881.....	51,500 00
<b>Total permanent Smithson fund in the Treasury of the United States, bearing interest at 6 per cent. per annum.</b>	<b>\$703,000 00</b>

## *Statement of the receipts and expenditures for the year 1881.*

### RECEIPTS.

Interest for the year 1881, from the United States.....	\$41,735 54
Sale of Virginia bonds and deferred certificates	50,514 98
Sale of Virginia coupons due January 1, 1881.	1,632 26
Balance cash on hand January 1, 1881 .....	20,934 52
<b>Total receipts.....</b>	<b>114,817 30</b>

## EXPENDITURES.

## For building :

Repairs and improvements .....	\$538 63	
Furniture and fixtures .....	572 07	
		\$1,110 70

## General expenses :

Meetings of the board .....	\$237 00	
Lighting the building .....	55 40	
Heating the building .....	996 75	
Postage and telegraph .....	43 01	
Stationery .....	962 86	
Incidentals, freight, hauling, ice, blanks, &c .....	1,027 97	
Books and periodicals .....	1,979 26	
Salaries and labor .....	13,266 50	
		18,568 75

## Publications and researches :

Smithsonian contributions .....	4,577 44	
Miscellaneous collections .....	3,170 03	
Annual reports .....	2,223 59	
Explorations .....	943 43	
		10,914 49

Literary and scientific exchanges .....	7,467 84	
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38,061 78

Cash deposited with the Treasurer of the United States to the credit of the Smithsonian fund, being proceeds of sale of the Virginia bonds (\$50,514.98) and part of coupons (\$985.02), by virtue of act of Congress, approved February 8, 1867 .....	51,500 00	
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Total expended .....		89,561 78
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Leaving balance on hand January 1, 1882 .....	25,255 52	
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## VIRGINIA BONDS.

At the meeting of the Board of Regents, 19th of January, 1881, the Executive Committee was authorized to dispose of the Virginia securities owned by the Institution, and to deposit the proceeds in the Treasury of the United States as an addition to the permanent fund.

The committee having duly considered the subject, decided to make the sale, which was effected through the agency of Messrs. Riggs & Co., bankers, with the following result:

\$53,700 00 par value, of Virginia consolidated bonds (sold at an average of about 79 per cent.) .....	\$46,417 87	
29,375 07 par value of Virginia deferred certificates, sold at about 13½ per cent .....	4,039 08	
50 13 par value of Virginia scrip, at 115½ .....	58 03	
88,125 20	Total .....	50,514 98

It is gratifying to state that the amount realized by the sale of the Virginia securities was \$3,514.98 more than their estimated value in our last annual report.

The coupons due on the Virginia bonds January 1, 1881, were sold by Messrs. Riggs & Co. January 31, 1881, as follows:

\$1,461 Virginia coupons, at 93½, less one-half per cent....	\$1,353 26
300 Virginia coupons, at 93½, less one-half per cent....	279 00
1,761 Total.....	1,632 26

Of this the committee used \$985.02 to add to the proceeds of the sale of the Virginia bonds, to make the even sum of \$51,500, to increase the permanent fund, as before stated, leaving the balance of \$647.24 for current expenses.

#### ESTIMATES FOR 1882.

The following are the estimates of receipts by the Institution proper for the year 1882, and of the expenditures required for carrying on its operations during the same period.

#### RECEIPTS.

Interest on the permanent Smithsonian fund, receivable July 1, 1882, and January 1, 1883.....	\$42,180 00
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#### EXPENDITURES.

For building and repairs .....	\$1,500 00
For general expenses, heating, lighting, &c., including salaries.....	19,000 00
For publications and researches.....	12,000 00
For exchanges ....	7,000 00
For contingencies.....	2,680 00
Total .....	\$42,180 00

#### NATIONAL MUSEUM AND OTHER OBJECTS COMMITTED BY CONGRESS TO THE SMITHSONIAN INSTITUTION.

The following appropriations were made by Congress in 1881, for disbursement under the direction of the Smithsonian Institution :

#### PRESERVATION OF COLLECTIONS.

"For preservation and care of the collections of the surveying and exploring expeditions of the government and for expense of heating, lighting, telephonic, and electrical service for the new Museum building." (Act March 3, 1881) .....	\$61,000 00
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"For transfer to, and arrangement in, the new National Museum building, of the collections of the United States surveying and exploring expeditions, and of the specimens presented to the United States at the International Exhibition of 1876." (Deficiency act, March 3, 1881) . . .		\$10,000 00
Total amount appropriated . . . . .	71,000 00	
Expended as per vouchers audited . . . . .	38,117 81	
Balance available January 1, 1882 . . . . .	32,882 19	

## ARMORY BUILDING.

"For watching, care, and storage of duplicate government collections, and of property of the United States Fish Commission." (Act March 3, 1881) . . . . .		\$2,500 00
Expended as per vouchers audited . . . . .	1,441 87	
Balance available January 1, 1882 . . . . .	1,058 13	

## FURNITURE AND FIXTURES.

"For cases, furniture, and fixtures required for the exhibition of the collections of geology, mineralogy, natural history, ethnology, and technology belonging to the United States." (Act March 3, 1881) . . . . .		\$60,000 00
Expended as per vouchers audited . . . . .	34,380 94	
Balance available January 1, 1882 . . . . .	25,619 06	

## FIRE-PROOF BUILDING, NATIONAL MUSEUM.

"For flooring of marble and encaustic tiles in the large halls of the National Museum Building." (Act February 9, 1881). \$26,000 00		
"For additional amount required for running the relieving sewer of the National Museum building into the north B street sewer instead of into the Seventh street sewer." (Act March 3, 1881) . . . . .		900 00
Total amount appropriated . . . . .	26,900 00	
Expended as per vouchers audited . . . . .	21,582 35	
Balance available January 1, 1882 . . . . .	5,317 65	

## NORTH AMERICAN ETHNOLOGY.

“For continuing ethnological researches among the North American Indians, under the direction of the secretary of the Smithsonian Institution, \$25,000, of which \$5,000 are to be expended in continuing archæological investigations relating to mound-builders and prehistoric mounds.” (Act March 3, 1881).....		\$25, 000 00
Expended as per vouchers audited .....		16, 459 10
		<hr/>
Balance available January 1, 1882. ....		8, 540 90
		<hr/> <hr/>

## INTERNATIONAL EXCHANGES.

“For the expense of exchanging literary and scientific productions with all nations by the Smithsonian Institution.” (Act March 3, 1881).....		\$3, 000 00
Expended as per vouchers audited .....		1, 500 00
		<hr/>
Balance available January 1, 1882.....		1, 500 00
		<hr/> <hr/>

## POLARIS REPORT.

Balance available January 1, 1881.....	\$6, 188 66
Expended .....	2, 585 91
	<hr/>
Balance available January 1, 1882.....	3, 597 75

## CONCLUSION.

The Executive Committee has examined 730 vouchers for payments made from the Smithsonian income during the year 1881, and 1,976 vouchers for payments made from appropriations by Congress for the National Museum, making a total of 2,706 vouchers. All these bear the approval of the Secretary of the Institution and a certificate that the materials and services charged were applied to the purposes of the Institution or of the Museum.

The Committee has examined the account books of the National Museum, and find the balances unexpended as before stated, viz: Preservation of collections, \$32,882.19; armory building, \$1,058.13; furniture and fixtures, \$25,619.06; international exchanges, \$1,500, to correspond with the certificates of the disbursing clerk of the Department of the Interior; and the balances for fire-proof building, National Museum, \$5,317.65; Polaris report, \$3,597.75, to correspond with the certificates of the disbursing clerk of the Treasury Department.

The quarterly accounts-current, bank-book, check-book, and journals have likewise been examined and found to be correct.



The balance to the credit of the Institution proper, on the 1st of January, 1882, in the hands of the Treasurer of the United States, available for the current operations of the Institution, is \$25,255.52.

Respectfully submitted.

PETER PARKER,  
JOHN MACLEAN,  
W. T. SHERMAN,

*Executive Committee.*

WASHINGTON, D. C., *January 16, 1882.*

Dr. Maclean's examination of the expenditures and vouchers was limited to those of the Smithsonian Institution proper.

## REPORT OF THE NATIONAL MUSEUM BUILDING COMMISSION FOR 1881.

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OFFICE OF THE SMITHSONIAN INSTITUTION,  
Washington, D. C., January 2, 1882.

*To the Board of Regents of the Smithsonian Institution:*

GENTLEMEN: By resolution of the Board of Regents of January 17, 1879, the Executive Committee of the Board and the Secretary of the Institution was authorized to "act for and in the name of the Board of Regents in carrying into effect the provision of any act of Congress that might be passed providing for the erection of a building for the National Museum," the care and administration of which establishment is entrusted to the Smithsonian Institution.

The anticipated provision having been made on the 3d of March, 1879, by a Congressional appropriation of \$250,000 "for a fire-proof building for the use of the National Museum, to be erected under the direction of the Regents of the Smithsonian Institution," in pursuance of authority vested in them by your Board, the Executive Committee and the Secretary, after organizing on the 7th of March, 1879, under the title of National Museum Building Commission, proceeded to adopt such measures as in their opinion appeared best calculated to realize, with the least possible delay, the intention of Congress.

At the session of the Board in January, 1880, the Commission had the honor to present to you a report of the operations connected with the construction of the new building from their inauguration to the close of 1879; and again, early in January, 1881, a similar report of progress during 1880 was submitted. These documents were respectively accompanied by reports of the superintending architects, which, while giving a technical and descriptive record of the plan, design, and construction of the building, presented accurately detailed exhibits of expenditures.

Having thus laid before you a record of operations of construction to the close of 1880, it only remains for the Commission to call the attention of the Board to those of the year just closed.

At the beginning of this period the balance to the credit of the appropriation was \$5,050.33, of which, however, \$1,000 was a specific appropriation for the construction of a sewer to relieve the building from water, which, on account of the inadequacy of the Seventh street sewer during extraordinary rains, would flood the cellars. It being ascertained subsequently, however, that this amount was insufficient, an additional \$900 was voted by Congress to be applied to sewer purposes. With the appro-

priation thus increased, the work was promptly begun and successfully carried to completion under the direction of the engineer of the District of Columbia, Lieutenant Hoxie, who is entitled to the thanks of the Board for this service.

Early in the year an appropriation of \$26,000 was granted to defray the expense of a tile floor for the naves and rotunda, and on its becoming available, plans for the work were prepared by the architects, from which a selection was made by the Commission and copies sent to various parties, with a request for proposals for executing the same. A number of proposals were received and opened on the 16th of April, the successful bidders being Mr. Emil Fritsch, of New York, for the marble tiles, and the United States Encaustic Tile Company, of Indianapolis, for the encaustic tiles for the rotunda. Both these parties have faithfully fulfilled their contracts; and with wood flooring on the halls that remained unfinished at the close of 1880, the two and a quarter acres of interior ground space of the building now presents a smooth and durable walking surface. In addition, the north front platform has been floored in a neat pattern of marble tiles, the inner vestibules of the four main entrances in encaustic tiles, and the outer vestibules laid in cement.

Owing to its insecure condition, the plaster covering was, during the summer, removed from all ceilings of the low, flat roofs. These, it will be remembered, consist of gratings of wood fastened between the iron girders and filled with mortar composed of plaster of Paris and ashes, a form of ceiling suggested by the consulting engineer, General Meigs. The surface exposed by removal of the plaster has been calcimined in subdued tints. In one of the outer halls thus treated a supplementary corrugated iron ceiling has been put in place, which, with the ceiling of gratings above, incloses an air space, serving to prevent the scape of heat in winter and renders the building cooler than formerly in summer.

In this connection it may be proper to state that the patentee of an apparatus for moistening air by means of a system of aspirators, whereby it is claimed that in hot weather a reduction of temperature of eight or ten degrees can be accomplished, and that the air is rendered more wholesome at all times, has offered to apply his invention to the new building for \$7,000. This apparatus is in use in certain cotton mills in New England for the purpose of improving the facilities of cotton spinning; but the question of its employment for the Museum is, of course, one for determination in the future.

An octagonal fountain basin, of twenty feet diameter, composed of a rim of molded polished granite and cement floor, has been erected in the rotunda. This, while a pleasing feature in an æsthetic point of view, materially lessened the expense for encaustic tiling by reducing the space to be floored.

The radiators remaining unfinished at the close of last year are now all bronzed and the steam-pipes covered with asbestos. The heating

apparatus continues to operate satisfactorily, both as regards the working of the various parts of the machinery and in an economical consumption of fuel. The severe winter of 1880-'81 subjected the apparatus to a test more trying than will be likely to occur again in many years.

For fuller information, however, in regard to operations of construction, as well as for details of expenditures, the Board is respectfully referred, as in previous reports of the Commission, to an appended statement of the superintending architects.

Although not directly connected with operations of construction, it is deemed not out of place to mention here that the use of the new building was granted for the reception ceremonies attending the inauguration of President Garfield on the evening of the 4th of March last, in view of the event being of a national character, and of the fact that the President-elect had been a Regent of the Smithsonian Institution for many years. No expense was incurred by the Museum in connection with this occupation.

Since the last meeting of the Board, the United States Geological Survey and the Bureau of Ethnology have been accommodated with quarters in the northeast pavilion, while space has also been freely provided for a large clerical force detailed by General Walker in connection with working up the fisheries statistics for the census report.

During the year the Commission has met as often as was deemed necessary. General M. C. Meigs, the consulting engineer, besides attending these meetings, has continued his visits to the building and given close and critical attention to the many features of its construction. For these and other valuable services he has rendered the Commission it is respectfully suggested that suitable acknowledgment be made by the Board of Regents.

It is very gratifying to the Commission to be able to state that the conscientious attention paid by the architects to the work they have had in hand in connection with the construction of the new edifice is in keeping with their professional reputation; also, that the *attachés* of the Commission generally have faithfully discharged every duty imposed upon them; and that while more than eight hundred vouchers, in duplicate, have been presented to the United States Treasury for payment, not a single one has been returned or otherwise questioned by the accounting officers.

In closing this its third annual report, the National Museum Building Commission congratulates the Regents that the new building for the National Museum is so far completed as to be ready for occupancy; and in now asking the Board to take charge of the edifice, the Commission begs to refer to the important fact that, while a building is presented equal in every respect to what was anticipated in case provision should be made for additional quarters for the national collections intrusted to the care of the Smithsonian Institution, instead of incurring

a deficiency, the fund has been so managed as to have to its credit at the present moment an available balance of some thousands of dollars.

Having fulfilled the duties with which it was charged by your resolution of January 17, 1879, the Commission would respectfully ask to be discharged, and to be authorized to turn over to the Secretary of the Smithsonian Institution the building itself, and to the United States Treasury whatever balance of money may remain after liquidating the last liability on account of the construction of the edifice.

Respectfully submitted.

W. T. SHERMAN,  
PETER PARKER,  
SPENCER F. BAIRD,  
*National Museum Building Commission.*

## REPORT OF THE ARCHITECTS OF THE NATIONAL MUSEUM BUILDING FOR 1881.

WASHINGTON, D. C., *January 1, 1882.*

To General W. T. SHERMAN,

*Chairman National Museum Building Commission :*

SIR : We have the honor to submit a report on the completion of various improvements in the National Museum Building, under the appropriations available for the purpose since January 1, 1881, the date of our last report.

To facilitate the carrying of steam to the great distances required for heating the offices at the four corners of the building, the steam mains were covered with thick layers of hair felt, protected by asbestos, as far as the funds would permit, and a favorable result was obtained.

The main halls were floored with white-veined, red, black, and gray marble tiles, laid in chaste patterns. The marble tiling was surrounded by a frieze of dark-blue Pennsylvania slate of sufficient thickness to bridge the ducts containing the steam-pipes, wires, &c. ; and around the frieze a border of parti-colored Portland cement pavement was extended.

This tiling covers about half an acre, and was obtained after public advertisement from the lowest bidder, Mr. E. Fritsch, of New York, who completed it satisfactorily about the middle of September.

An octagonal fountain, with sides of molded and polished granite, and floor of Portland cement, was constructed and finished in the early part of August. The floor of the rotunda around the fountain was laid with encaustic tile, according to our designs.

Proposals for these tiles were invited from all the manufacturers in this line in the country, as well as from the leading importers. The United States Encaustic Tile Company, of Indianapolis, Ind., was awarded the work as the lowest bidder, and completed it quite satisfactorily about the 1st of October. It is a creditable specimen of a branch of industry now being successfully introduced in the country.

The four square halls were floored with best Georgia yellow pine, laid upon a concrete base, since this material was preferred for special reasons.

The spacious platform in front of the northern main entrance was laid with a floor of ornamental marble tile.

A sewer has been constructed through the Smithsonian grounds, directly to the main sewer along North B street, and the building is now disconnected from the overcharged branch sewers of the city.

All the plumbing fixtures necessary or proper to be introduced in the building for safety, for the accommodation of visitors, as well as officials, such as fire-plugs, sinks, wash-basins, water-closets, and urinals, were provided for and constructed during the season in strict accordance with the present requirements of sanitary science.

A large number (thirty-two) of the sash-windows in the lanterns of the main and square halls have been made movable in sections by simple mechanism worked from the floors of the halls. This improvement has proved to be a valuable agent for summer ventilation during the hot spells peculiar to our climate.

Several partitions of fire-proof concrete material have been constructed in the two eastern corner pavilions for the better accommodation of the service.

An important improvement has been introduced in one of the outside halls by the construction and hanging of a comely iron ceiling underneath, and parted by an air space, from the roof. The double ceiling has added materially to the sanitary advantages of the building, and it is highly desirable to have it extended over the whole building.

The slates of the roofs are hung to iron purlines, and are plastered on their under side with a heavy coat of mortar. During rapid changes of the temperature, moisture arising from the process of condensation of aerial vapor appears occasionally on this plastered surface which forms the ceiling of the principal halls; this will be obviated by the hung iron ceiling with air space between it and the plastered slates.

The roofs and ceilings of the lower halls are formed by sheet metal laid upon fire-proofed gratings, which are again plastered on the under side. The adherence of the plasterer's mortar to the greasy fire-proof composition has proved to be insufficient, and it fell in a number of patches. The whole surface so covered, aggregating about 3,600 square yards, and costing about \$720, was hence removed, and the proposed iron ceilings will incidentally serve to hide the unsightly surface of the exposed gratings.

The action of the rapid changes of the temperature during our summer months, in causing expansion and contraction of building material disposed in great lengths throughout this extensive structure, has occasionally baffled the provided safeguards. It has been carefully watched, and small imperfections have been remedied wherever and as soon as they appeared. With comparatively little more attention they will be completely under control.

## FINANCIAL STATEMENT.

The available funds were :

Balance from former appropriations in hands of the disbursing agent on January 1, 1881 . . . . .	\$5,050 33
Appropriation by Congress for tile-floors, &c. . . . .	26,000 00
Additional appropriation for sewer to North B street . . . . .	900 00
	<hr/>
	31,950 33

## SCHEDULE ACCOUNT OF EXPENDITURES TO JANUARY 1, 1882.

## Heating apparatus :

For steam-fitters' work and material . . . . .	\$3,418 18
For non-conducting lining around steam-pipes . . . . .	732 85
	<hr/>
	\$4,151 03

## Floors :

## A.—Marble-slate tiling of four main halls :

Tile and labor of laying . . . . .	8,756 63
Cement . . . . .	1,257 45
Sand . . . . .	152 25
Miscellaneous labor . . . . .	53 33
Wall borders of ornamental cement work . . . . .	1,014 05

## B.—Floor of rotunda :

Fountain . . . . .	957 12
Encaustic tiling (outstanding, \$1,934.29).	

## C.—Tiled platform in front of main entrance . . . . . 595 10

## D.—Floors of four square halls . . . . . 2,081 53

## E.—Cement pavements outside of building . . . . . 268 77

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15,136 23

## Fire-proof partitions :

Construction . . . . .	280 40
Plastering . . . . .	59 00
	<hr/>
	339 40

## Ventilation :

Movable sash in lanterns of main and square halls . . . . .	531 20
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## Iron ceilings :

One iron ceiling over southwest outer hall . . . . .	962 10
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## Sewer :

Cost of main sewer through Smithsonian grounds . . . . .	1,437 17
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## Miscellaneous :

Decorations . . . . .	80 00
Additional step-railings . . . . .	662 18
Improvements to roofs, down-spouts, galvanized-iron work, finishings of plastering . . . . .	949 51



**Miscellaneous—Continued.**

Printing, advertising, and photographing.....	\$213 86
Clerk hire and notary fees .....	345 00
Construction and superintendence.....	1, 750 00
Balance in hands of disbursing agent on December 31, 1881 .....	5, 392 65
	<hr/>
	31, 950 33

The balance in hand will suffice to pay up all outstanding liabilities.

We have the honor to be, very respectfully, your obedient servants,

CLUSS & SCHULZE,

*Supervising Architects.*

## ACTS AND RESOLUTIONS OF CONGRESS RELATIVE TO THE SMITHSONIAN INSTITUTION AND NATIONAL MUSEUM.

*In continuation from previous reports.*

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CHAP. 179. An act extending the privilege of the Library of Congress to the Regents of the Smithsonian Institution.

*Be it enacted, &c.,* That the Joint Committee of both Houses of Congress on the Library, be authorized to extend the use of the books in the Library of Congress to the Regents of the Smithsonian Institution, resident in Washington, on the same conditions and restrictions as members of Congress are allowed to use the Library.

Approved March 3, 1875.

(Stat., vol. 18, sec. 512; Revised Statutes, supplement, vol. 1, page 195.)

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CHAP. 103. An act establishing post-roads, and for other purposes.

*Be it enacted, &c. :*

SEC. 5. That it shall be lawful to transmit through the mail, free of postage, any letters, packages, or other matters relating exclusively to the business of the Government of the United States: *Provided*, That every such letter or package, to entitle it to pass free, shall bear over the words "Official business" an endorsement showing also the name of the department, and, if from a bureau or office, the names of the department and bureau or office, as the case may be, whence transmitted. And if any person shall make use of any such official envelope to avoid the payment of postage on his private letter, package, or other matter in the mail, the person so offending shall be deemed guilty of a misdemeanor, and subject to a fine of three hundred dollars, to be prosecuted in any court of competent jurisdiction.

SEC. 6. That for the purpose of carrying this act into effect, it shall be the duty of each of the executive departments of the United States to provide for itself and its subordinate offices, the necessary envelopes; and, in addition to the endorsement designating the department in which they are to be used, the penalty for the unlawful use of these envelopes shall be stated thereon.

Approved March 3, 1877.

(Revised Statutes, supplement, vol. 1, page 288.)

[Extended to the Smithsonian Institution by act of March 3, 1879, as follows:]

CHAP. 180. An act making appropriations for the service of the Post-Office Department for the fiscal year ending June 30, 1880, and for other purposes.

*Be it enacted, &c.,* . . . the provisions of said fifth and sixth sections are hereby likewise extended and made applicable to all official mail matter sent from the Smithsonian Institution.

Approved March 3, 1879.

(Revised Statutes, supplement, vol. 1, page 458.)

JOINT RESOLUTION [No. 22] providing for the distribution and sale of the new edition of the Revised Statutes of the United States.

*Resolved, &c.,* That the . . . copies of the new edition of the first volume of the Revised Statutes of the United States . . . be disposed of by the Secretary of State as follows: . . . to the Smithsonian Institution, two copies. . . .

Approved May 22, 1878.

(Revised Statutes, supplement, vol 1, page 387.)

CHAP. 182. An act making appropriations for sundry civil expenses of the government for the fiscal year ending June 30, 1880, and for other purposes.

Sect. 1, Par. 12. That all the archives, records, and materials relating to the Indians of North America, collected by the Geographical and Geological Survey of the Rocky Mountain region, shall be turned over to the Smithsonian Institution, that the work may be completed and prepared for publication under its direction: *Provided*, That it shall meet the approval of the Secretary of the Interior and of the Secretary of the Smithsonian Institution.

Approved March 3, 1879.

(Revised Statutes, supplement, vol. 1, page 461.)

JOINT RESOLUTION [No. 11] concerning an international fishery exhibition to be held in Berlin, Germany, in April, eighteen hundred and eighty.

Whereas all civilized nations take part in the International Fishery Exhibition to be held in the city of Berlin, Germany, in April, eighteen hundred and eighty, it is deemed both right and expedient that the prominent and effective action of the United States in the line of the artificial propagation of fish and the stocking of depleted fishing waters should be conspicuously and well exhibited on the occasion: Therefore,

*Resolved by the Senate and House of Representatives of the United States of America in Congress assembled*, That to enable the United States Commissioner of Fish and Fisheries to exhibit in Berlin, in April, eighteen hundred and eighty, a fair and full collection of the different specimens of American food fishes, casts thereof, models of, and implements, and so forth, used in the prosecution of American fisheries, the sum of twenty thousand dollars is hereby appropriated out of any moneys not otherwise appropriated in the Treasury of the United States, or so much

thereof as may be necessary for the purpose, to be immediately available on the passage of this resolution, to be expended under the direction of the Secretary of State.

SEC. 2. That the United States Commissioner of Fish and Fisheries be, and is hereby, authorized to represent the United States, either in person or by a deputy to be appointed by the President of the United States; and that, at his discretion, he may use any portion of the collections at present forming part of the National Museum in making up the proposed exhibition by the United States.

SEC. 3. That the United States Commissioner of Fish and Fisheries be, and is hereby, instructed to present to Congress, through the Department of State, a report upon the Berlin exhibition, showing the recent progress and present condition of the fisheries and of fish-culture in foreign countries.

Approved February 16, 1880.

(Statutes, vol. 21, page 301).

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CHAP. 73. An act making appropriations for the naval service for the fiscal year ending June thirtieth, eighteen hundred and eighty-one, and for other purposes.

*Naval Observatory.*—For payment to the Smithsonian Institution for freight on Observatory publications for eighteen hundred and eighty, to be shipped in eighteen hundred and eighty, two hundred and thirty-six dollars and twenty-five cents.

Approved May 3, 1880.

(Statutes, vol. 21, page 84.)

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For payment to the Smithsonian Institution for freight on Observatory publications for eighteen hundred and eighty-one, to be shipped to foreign countries in eighteen hundred and eighty-one, two hundred and thirty-six dollars and twenty-five cents.

Approved May 3, 1880.

(Statutes, vol. 21, page 84.)

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CHAP. 42. An act making an appropriation for the flooring of the National Museum.

*Be it enacted, &c.,* That the sum of twenty-six thousand dollars, or so much thereof as may be necessary, be, and the same hereby is, appropriated out of any money in the Treasury not otherwise appropriated, to place a flooring of marble and encaustic tiles in the large halls of the National Museum building, to be expended according to plans and under the direction of the building commission of the Board of Regents of the Smithsonian Institution under whose supervision the museum has been constructed.

Approved February 9, 1881.

(Statutes, vol. 21, page 324.)

JOINT RESOLUTION [No. 12] authorizing the Public Printer to print reports of the United States Fish Commissioner upon new discoveries in regard to fish culture.

*Resolved, &c.,* That the Public Printer be, and he hereby is, instructed to print and stereotype, from time to time, the regular number of nineteen hundred copies of any matter furnished him by the United States Commissioner of Fish and Fisheries relative to new observations, discoveries, and applications connected with fish culture and the fisheries, to be capable of being distributed in parts, and the whole to form an annual volume or bulletin not exceeding five hundred pages. The edition of said annual work shall consist of five thousand copies, of which two thousand five hundred shall be for the use of the House of Representatives, one thousand for the use of the Senate, and one thousand five hundred for the use of the Commissioner of Fish and Fisheries.

Approved February 14, 1881.

(Revised Statutes, supplement, vol. 1, page 617.)

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CHAP. 65. An act to provide for remitting the duties on the object of art awarded by the Berlin International Fishery Commission to Professor Spencer F. Baird.

*Be it enacted,* That the Secretary of the Treasury be, and he hereby is, directed to remit the customs duties chargeable upon the object of art given by His Majesty the German Emperor and King of Prussia to the Berlin International Fishery Exhibition, and by it awarded as the first grand prize of honor to Professor Spencer F. Baird, at the exhibition held in the city of Berlin, Prussia, in the month of June, eighteen hundred and eighty.

Approved February 21, 1881.

(Statutes, vol. 21, page 608.)

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CHAP. 73. An act making appropriations for the naval service for the fiscal year ending June 30, 1881, and for other purposes.

*Naval Observatory.*—For payment to the Smithsonian Institution for freight on Observatory publications to be shipped to foreign countries during the fiscal year eighteen hundred and eighty-two, three hundred and thirty-six dollars and twenty-five cents.

Approved February 23, 1881.

(Statutes, vol. 21, page 333.)

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CHAP. 132. An act making appropriations to supply deficiencies in the appropriations for the fiscal year ending June 30, 1881, and for prior years, and for those certified as due by the accounting officers of the Treasury in accordance with section four of the act of June 14, 1878, and heretofore paid from permanent appropriations, and for other purposes.

For additional amount required for running the relieving sewer of the National Museum building into the North B street sewer instead of into the Seventh street sewer, nine hundred dollars.

Approved March 3, 1881.

(Statutes, vol. 21, page 418.)

(Same act.)

For expense of transfer to and arrangement in the new National Museum building of the collections of the United States surveying and exploring expeditions, and of the specimens presented to the United States at the international exhibition of eighteen hundred and seventy-six, ten thousand dollars, being for the service of the current fiscal year.

Approved March 3, 1881.

(Statutes, vol. 21, page 418.)

CHAP. 133. An act making appropriations for sundry civil expenses of the government for the fiscal year ending June 30, 1882, and for other purposes.

For the expense of exchanging literary and scientific productions with all nations by the Smithsonian Institution, three thousand dollars.

*Preservation of collections, Smithsonian Institution.*—For preservation and care of the collections of the surveying and exploring expeditions of the government, fifty-five thousand dollars.

*Preservation of collections, Smithsonian Institution, Armory building.*—For expense of watching, care, and storage of duplicate government collections, and of property of the United States Fish Commission, two thousand five hundred dollars.

Approved March 3, 1881.

(Statutes, vol 21, page 452.)

(Same act.)

*North American ethnology, Smithsonian Institution.*—For the purpose of continuing ethnological researches among the North American Indians, under the direction of the Secretary of the Smithsonian Institution, twenty-five thousand dollars; five thousand dollars of which shall be expended in continuing archæological investigations relating to mound-builders and prehistoric mounds, and be available immediately.

Approved March 3, 1881.

(Statutes, vol. 21, page 443.)

(Same act.)

*Furniture and fixtures, National Museum.*—For cases, furniture, and fixtures required for the exhibition of the collections of geology, mineralogy, natural history, ethnology, and technology, belonging to the United States, sixty thousand dollars.

*Heating and lighting National Museum.*—For expense of heating, lighting, telephonic and electrical service for the new museum building, six thousand dollars.

Approved March 3, 1881.

(Statutes, vol. 21, page 449.)

(Same act.)

*Buildings and Grounds in and around Washington and the Executive Mansion.*—For asphaltum footwalks through Smithsonian grounds from Seventh to Twelfth streets, one thousand five hundred dollars.

Approved March 3, 1881.

(Statutes, vol. 21, page 444.)

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(Same act.)

*Miscellaneous objects under War Department.*—For transportation of reports and maps to foreign countries through the Smithsonian Institution, five hundred dollars.

Approved March 3, 1881.

(Statutes, vol. 21, page 447.)

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JOINT RESOLUTION [No. 26] authorizing the Secretary of the Treasury to furnish States, for the use of agricultural colleges, one set of standard weights and measures, and for other purposes.

*Resolved, &c.*, That the Secretary of the Treasury be, and he is hereby, directed to cause a complete set of all the weights and measures adopted as standards to be delivered to the governor of each State in the Union, for the use of agricultural colleges in the States, respectively, which have received a grant of lands from the United States, and also one set of the same for the use of the Smithsonian Institution: *Provided*, That the cost of each set shall not exceed two hundred dollars, and a sum sufficient to carry out the provisions of this resolution is hereby appropriated out of any money in the Treasury not otherwise appropriated.

Approved March 3, 1881.

(Statutes, vol. 21, page 521.)

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**GENERAL APPENDIX**

**TO THE**

**SMITHSONIAN REPORT FOR 1881.**

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## ADVERTISEMENT.

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The object of the GENERAL APPENDIX is to furnish summaries of scientific discovery in particular directions; occasional reports of the investigations made by collaborators of the Institution; memoirs of a general character or on special topics, whether original and prepared expressly for the purpose, or selected from foreign journals and proceedings; and briefly to present (as fully as space will permit) such papers not published in the "Smithsonian Contributions" or in the "Miscellaneous Collections" as may be supposed to be of interest or value to the numerous correspondents of the Institution.

# RECORD OF SCIENTIFIC PROGRESS FOR 1881.

## INTRODUCTION.

While it has been a prominent object of the Board of Regents of the Smithsonian Institution from a very early date in its history to enrich the annual report required of them by law, with scientific memoirs illustrating the more remarkable and important developments in physical and biological discovery, as well as showing the general character of the operations of the Institution, this purpose had not been carried out on any very systematic plan. Believing however that an annual report or summary of the recent advances made in the leading departments of scientific inquiry would supply a want very generally felt, and would be favorably received by all those interested in the diffusion of knowledge, the Secretary had prepared for the report of 1880, by competent collaborators, a series of abstracts showing concisely the prominent features of recent scientific progress in astronomy, geology, physics, chemistry, mineralogy, botany, zoölogy, and anthropology.

The subjects of terrestrial physics and meteorology (which should properly have succeeded the survey of geology) were unfortunately omitted, in consequence of the inability of the writer selected for these departments to obtain sufficient leisure from other pressing duties to prepare a suitable abstract in time. This omission has been partially supplied in the record for the present year by including a meteorological retrospect for the years 1879 and 1880.

The subjects of geology and mineralogy, which were referred to Mr. George W. Hawes, of the National Museum (who had acceptably prepared this summary for the record of 1880), have been delayed this year by the prolonged and much-regretted illness of Mr. Hawes; and it has been found impossible to obtain in time a substitute in this department.

With every effort to secure prompt attention to all the more important details of such a work, various unexpected delays frequently render it impracticable to obtain all the desired reports in each department within the time prescribed. In such cases it is designed, if possible, to bring up such deficiencies and supply them in subsequent reports.

The value of this annual record of progress would be much enhanced by an enlargement of its scope, and the inclusion, not only of such branches as geography, microscopy, &c., but also of the more practical topics of agricultural and horticultural economy, engineering, and tech-

nology in general; but the space required for such larger digest seems scarcely available in the present channel. The scientific résumé, which in 1880 occupied 260 pages, has this year extended to 330 pages. An efficient condensation of this matter seems scarcely practicable.

It is hardly necessary to remark that in a summary of the annual progress of scientific discovery so condensed as the present, the wants of the specialist in any branch can be but imperfectly supplied; and very many items and details of great value to him must be entirely omitted. While the student in a special field of knowledge may occasionally receive hints that will be found of interest, he will naturally be led to consult for fuller information the original journals and special periodicals from which these brief notices or abstracts have been compiled.

The contemplated plan of devoting some 250 pages of the annual report to such a compilation is not designed to preclude the introduction into the "General Appendix," as heretofore, of special monographs or discussions that may prove interesting to the scientific student.

SPENCER F. BAIRD.

# ASTRONOMY.

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BY PROF. EDWARD S. HOLDEN,  
*Director of the Washburn Observatory, Wisconsin.*

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## INTRODUCTION.

The record of astronomical progress for 1881 must necessarily be a very condensed summary. It is to be remembered that this review is not primarily intended for astronomers, but is specially addressed to the correspondents of the Smithsonian Institution. For bibliographic information the reader is referred to DARBOUX et HOUEL's *Bulletin des Sciences Mathématiques et Astronomiques* (monthly, Paris), to *Nature* (weekly, London), to *Science* (weekly, New York), to *Copernicus*, (monthly, Dublin), to the *Observatory*, (monthly, London), and to other standard journals. Free use has been made of reviews by writers in these and other periodicals.

## NEBULÆ AND CLUSTERS.

*Photographs of nebulae.*—M. J. Janssen calls attention to the effect of short and long exposures upon the negatives which are obtained. Photographs of the same nebula will not agree unless the same conditions of exposure are narrowly observed. In proof of this the photographs of the solar corona taken at Siam in the eclipse of 1875 are referred to: The nebulosity, so to speak, of the corona gave different impressions upon sensitive plates which were exposed during times expressed by the numbers 1, 2, 4, 8; and it must be inferred that the changes in the height of the corona are to be attributed to the times of exposure, instead of to actual variations in the extent of the phenomena. M. Janssen proposes to take the photograph of the image of a star, or nebula, a little out of focus. In this case the photograph is a little circle of sensibly uniform opacity, and one can compare the opacity of the photographs of different stars, and connect the degrees of opacity with the photometric power.—*Comptes Rendus*.

The Publications of the Washburn Observatory No. 1 contain a list of 23 new nebulae, mostly faint.

*Cluster measurements.*—H. C. Russell, director of the observatory of Sydney, has made a micrometric examination of the cluster h. 3276 = G. C. 2144, which gives the positions (and magnitudes) of 144 stars. One of these is an interesting red star. The paper is accompanied by a map of the cluster made by Mr. Russell, himself, by a process which he describes as extremely easy for any one to execute.

## FIXED STARS.

*Catalogue of stars.*—"Catalogue of 12,441 stars for the epoch 1880, from observations made at the Royal Observatory, Cape of Good Hope, during the years 1871 to 1879. Edward James Stone, M. A., F. R. S., etc. (London, 1881, XXXII, and 565, 4to)." This catalogue, published by the Admiralty, is founded on observations made at the Cape Observatory between January, 1871, and April, 1879. The observatory during the whole period was steadily directed to the object in view, the formation of a catalogue of well-distributed stellar zero-points for those portions of the heavens which are beyond the reach of northern observatories. But a considerable number of stars, north of  $25^{\circ}$  Decl., were also observed at the Cape, and the results have been included in the present catalogue as a check upon the existence of any systematic errors in the work. Lacaille's well-distributed 9,766 stars were adapted as the basis of the working list, but as some stars of the sixth and many of the seventh magnitude, in Brisbane's Catalogue of 7,385 stars, had not been observed by Lacaille, the greater part of these were also included in the working list. A large stereographic projection of the southern hemisphere was also prepared, on which were projected the places of all the stars previously observed, and whenever lacunæ appeared within the limits of N. P. D.  $115^{\circ}$  to  $180^{\circ}$ , efforts were made to fill them up by observing stars of rather a lower magnitude than the seventh of Lacaille's scale. A reduced copy of this projection accompanies the catalogue. Generally each star was observed three times.

The right ascensions of the stars observed for the determination of the errors of the Transit-clock have been taken from the Greenwich Standard Lists for the different years. The Right Ascensions of Polar Stars were taken from Mr. Stone's paper on "The mean places of eight close Southern Polar Stars, 1860 to 1900." The refractions used are those of the *Tabulæ Regiomontanæ* diminished in the proportion of 0.9988: 1, but the use of Bessel's tables unaltered would not change the results of the Catalogue by  $0''.2$ . As a proof of the satisfactory character of the adopted refractions, a comparison is given between the results of the Catalogue and the places of the *Nautical Almanac* for 1880. As might be expected from the use of the same fundamental system, there is a close agreement between the Greenwich and Cape Right Ascensions, but the perfectly independent determinations of N. P. D. are also in very good accordance. Arranging the corrections required by the *Nautical Almanac* N. P. D.'s in groups of 6 hours of R. A. and applying the general mean correction— $0''.81$  to them all, the following corrections remain:

$0^h - 6^h$	$6^h - 12^h$	$12^h - 18^h$	$18^h - 24^h$
$-0''.24$	$-0''.11$	$+0''.39$	$+0''.06$

The changes in these corrections are systematic, and it appears that the complete reversal of the seasons at the northern and southern observatories is not quite accurately allowed for in the refraction tables. In

notes at the end of the catalogue are given the larger proper motions resulting from a comparison of the Catalogue for 1880 with the "Cape Catalogue for 1840," and Taylor's "Subsidiary Catalogue for 1850." In the catalogue the mean time of observation is given for all the stars, but in forming the mean positions the proper motion has only been applied in the comparatively few cases where the proper motion is given in the body of the catalogue. The latter contains, in separate columns, references to Piazzzi, Brisbane, Fallows, Johnson, Henderson, Taylor, Cape 1840, Cape 1860, and Melbourne 1870, and in foot-notes other references, as also corrections to previous catalogues, and remarks about duplicity, false positions, etc. Lacaille's numbers are given in the second column next to the current number of the catalogue. The constellations occupy the third column; Lacaille's system of nomenclature is used with the modifications proposed by Sir J. Herschel. The importance of this great work can hardly be overestimated. Valuable as the two previously published Cape Catalogues and Melbourne Catalogue for 1870 are, they cannot compare with it either as regards extent or completeness, and when it is remembered how uncertain the foundation is on which Lacaille's zones rest, and how poor and unreliable the Brisbane Catalogue is, it will be conceded by everybody that Mr. Stone's Catalogue will be an inestimable treasure for future generations, the value of which will continue to increase. As remarked by its author, the catalogue may also render good assistance in investigations on special stars occurring in Lacaille's and Brisbane's Catalogues, or even in completely new re-reductions of the observations on which these catalogues are founded.

"Catalogue of 1098 Standard Clock and Zodiacal Stars, prepared under the direction of Simon Newcomb" (papers prepared for the use of the American Ephemeris, No. 4, 162 pp., 4to). This catalogue was prepared for the purpose of obtaining standard positions of reference stars for use in the lunar and planetary theories, especially in the reduction of the older occultations. It contains all the standard stars of the Ephemeris (except most of those added for field work), and all stars to the sixth magnitude inclusive, which can be occulted by the moon, together with stars below the sixth magnitude observed by Bradley. The author was able to use Auwers' reduction of Bradley. The declinations of the catalogue are reduced to Mr. Boss' system, which was only modified so far as to substitute Auwers' reduction of Bradley for that of Bessel. In the case of stars within  $80^\circ$  of the pole, the right ascensions were not independently investigated, but were taken from Dr. Gould's Catalogue (second edition), while the declinations are those of Mr. Boss. The catalogue gives, in the case of the stars observed by Bradley, the positions and other data for the two epochs 1755 and 1850, while in the case of fundamental time-stars the positions are also given for 1,900. Stars between  $10^\circ$  and  $30^\circ$  from the pole have data given for the epochs 1755, 1800, 1850, and 1900, and stars still nearer the pole also for 1825 and 1875. The precessions

and secular variations for each epoch are independently computed. Formulæ for finding the place of a star for any epoch between 1750 and 1900 from the data in the catalogue by Taylor's theorem add to the general usefulness of Professor Newcomb's work, which will no doubt be extensively employed by astronomers who have to reduce lunar or planetary observations made during the last and the present century.

Dr. Gould has printed his second volume (Cordoba observations of 1872), except the introduction. It contains the places of 400 stars for the catalogue, and also 128 zones of the zone observations, comprising over 13,000 stars. All the observations made at Cordoba are now fully reduced and they make a grand showing:

121, 000 observations for the catalogue of 35,000 stars.

14, 000 observations of fundamental stars.

105, 000 observations for the zones.

240, 000 observations in all.

Of these about half (including *all* the zones) were made by Dr. Gould personally. The total number of stars will be somewhere in the neighborhood of 80,000 in the zones, and 30,000 to 35,000 stars in the catalogue.

The work is all ready for the printer up to the end of 1875, but much remains to be done to put it in final shape from 1875 to 1880. The printing is an extremely slow process in Buenos Ayres, and the meteorological volumes (2 of which have appeared) are sources of delay.

Among recent catalogues of stars may be cited that published by Professor Respighi in vol. VIII of the *Atti della R. Accademia dei Lincei*. It contains the mean declinations for 1875 of 1,463 stars between the parallels of 20° and 64° north, deduced from observations with the meridian circle of the Royal Observatory of Campidoglio in the years 1875, 1876, and 1877.

The separate publication of the Berlin list of 539 stars will cease with 1881, and a selection from this list will appear in the *Berliner Jahrbuch*.

A catalogue of 195 stars is printed in No. 1 of the Publications of the Washburn Observatory. The observations were made at Ann Arbor by Mr. Schaeberle, the reductions at Madison by Mr. Comstock, under the direction of Professor Watson.

Each star was observed three times on the average, and the probable errors in R. A. and Dec. of the concluded positions are:

$\pm 0^s. 040$  sec  $\delta$  and

$\pm 0''. 55$  respectively.

The zones of the *Astronomische Gesellschaft* from 80° to -2° are now nearly finished. Kasan (80-75), Dorpat (75-70), Christiania (70-65), Gotha (65-55), Harvard College (55-50), Bonn (50-40), have all finished the observations, and the reductions are nearly done. Lund (40-35) will finish observing in 1881. Leyden (35-30) will soon publish the

final results. Cambridge, England (30–25), is well advanced in reduction. Berlin has two zones; 25–20 is in progress, 20–15 is finished. Leipzig also has two zones; 15–10 is finished, and 10–5 is in progress. Albany (5–1) is far advanced. Nicolajeff (1 to –2) is well under way.

*Parallax of stars.*—Professor Ball, Royal Astronomer for Ireland, found for the parallax of 61 *Cygni*, as deduced from measures of 61 A *Cygni* and a small star n. f.,

$$+0''.4654 \pm 0''.0497.$$

A second series has been completed in which 61 B *Cygni* and the small star n. f. were used. Differences of declinations were measured in both cases. The last result is—

$$+0''.4676 \pm 0''.0321.$$

That is, the agreement is exact, and Struve's value for the parallax of this system is confirmed rather than Bessel's.

The search for objects having curious spectra, which has been carried on for some months at the Harvard College Observatory, has led to the discovery of another singular star by Prof. E. C. Pickering. The spectrum consists principally of bright bands, one in the blue being especially marked. Only four objects of this kind have heretofore been known, one of these having been discovered likewise at Cambridge, Mass., last August. This same method of search, which originated last summer at the Harvard College Observatory, has been adopted at the observatory of the Earl of Crawford and Balcarres, and Dr. Copeland has already shown that a curious double nebula is gaseous. It will also be introduced in the Royal Observatory at the Cape of Good Hope, and there applied to extreme southern objects.

*Variable Stars.*—"Photometric Measurements of the Variable Stars  $\beta$  Persei and DM. 81° 25. By Edward C. Pickering, Arthur Searle, and O. C. Wendell," (Proc. Amer. Acad., Vol. XVI, 28 pp.). The photometer used at Harvard College Observatory for the observation of these two variables consists of a double-image prism placed between the object glass and the eye-piece of a small telescope, which has a Nicol prism in front of the eye-piece. By this instrument two adjacent stars may be compared with great accuracy, as the two images of each will be formed by the double-image prism, and their relative brightness may be varied by turning the Nicol. Each image in turn will disappear when the Nicol is turned 90°, and there will consequently always be four positions in which the brighter image of the fainter star will be precisely equal to the fainter image of the brighter star.  $\beta$  Persei was compared with the fifth magnitude star  $\omega$  Persei 90' distant. The two images were formed by two Rochon prisms which produced a separation of about 100', so that they had to be placed very near the object glass of the telescope in order that the images of the two



stars should be near together. The focal length of the telescope is about seventeen feet, and its available aperture is limited by the size of the prisms to about an inch. Observations were made on thirteen nights, from September 29, 1880, to January 1, 1881. Three settings of each of the four positions of the Nicol constituted a set; the total number of sets was 230. Seven minima were observed, and the probable error of a single minimum is 3.8 minutes, while Schmidt gives the probable error of a minimum observed by Argelander equal to 6 minutes, and of those of Schönfeld 4.6 minutes. A comparison is made between the light curves found by Schönfeld, and at Harvard College Observatory, and the photometric and naked-eye methods are found to agree closely. For the observation of Ceraski's variable star  $+81^{\circ}$  No. 25, the photometer was attached to the 15 inch refractor, on account of the faintness of the star. Two hundred and seventy-three sets of measures were made, and five minima were observed. The average probable error of a minimum is 1.3 minute, or about one-third of that of  $\beta$  Persei, which was to be expected since the rate of variation of the stars is about as three to one. Some interesting theoretical conclusions are drawn from the resulting light curve. For about an hour and a half the light remains sensibly constant at 0.110, or about one-ninth of its full intensity. This interval is over one-third of that during which the light is increasing or diminishing. If the variation in light is admitted to be due to a dark eclipsing satellite, the diameter of the latter must be  $\sqrt{1-0.110} = 0.943$  of that of the star, in order to sufficiently reduce the light. A somewhat smaller diameter is possible, if we admit that the star, like our Sun, is darker near the edges than in the center. But the difference cannot be great; or it would show itself in other ways. The longest period of uniform minimum light would occur if the satellite produced a central annular eclipse. In this case if the motion was uniform, the duration of the minimum light would equal only one-ninth of that of increase or decrease. The effect of curvature or ellipticity of the path would not greatly affect this conclusion. A very great ellipticity is not admissible, or at the periastron the satellite would strike the star. We are, therefore, obliged to admit that the star is entirely covered by the satellite, and that the light during the minimum is either due to some proper light of the satellite, or is to be explained by admitting that the satellite consists of a cloud of meteors so scattered that about one-ninth of the light of the star can pass through the central portions.

On September 13, 1881, a red star was noticed at the Harvard College Observatory in R. A.  $16^{\text{h}} 31^{\text{m}}.5$ , Dec.  $+ 72^{\circ} 32'$ . From the similarity of its spectrum to that of several known variable stars, it was presumed to be variable; and the suspicion was confirmed, both by its absence from the catalogues and by subsequent observation, which showed that its brightness was increasing.

already about 64,000 zone stars have been observed and mapped. Quite as many more of the fainter stars are needed to complete the maps, and perhaps half of these are now mapped. We possess several series of ecliptic charts, more or less complete. These are:

1st. Charts by Hind, on which the smallest star is about 11 mag.

2d. Charts by Chacornac, *minimum visibile*, 13 mag.

3d. Charts published by the Paris Observatory, in continuation of CHACORNAC'S, *minimum visibile*, 13 mag.

The smallest stars laid down on Dr. Peters' charts are 14.8 mag.

The charts of Chacornac and those of the Paris Observatory are extremely useful, but by no means so complete as those of Dr. Peters; and, in general, they do not cover the same place in the heavens. No. 31 of the Paris charts, however, occupies the same ground as one of Dr. Peters' charts. On May 17, 1878, I compared the Paris chart No. 31 with the sky, and at the same time I compared Dr. Peters' chart of the same region; and on the following day the two maps were compared together.

The Paris chart No. 31 contains 1,554 stars, and extends from  $10^h 0^m$  to  $10^h 21^m$  B. A., and from  $+8^\circ 45'$  to  $+14^\circ 0'$   $\delta$ ; the Hamilton College chart, covering nearly the same ground, extends from  $10^h 0^m$  to  $10^h 20^m$  R. A., and from  $+10^\circ$  to  $15^\circ$  in  $\delta$ . The number of stars laid down on the space common to both (from  $10^h 0^m$  to  $10^h 16^m$ , and from  $+10^\circ$  to  $+14^\circ$ ) is, according to the Paris chart, 1,010 stars; according to Dr. Peters' chart, 1,511 stars; or almost exactly one-half more in the latter.

I found more than thirty cases where the stars of the Paris chart were either much too large or too small, or where they occupied places where no stars now are. In all these cases the Hamilton College chart was correct.

Errors in position I naturally could not verify in the time at my disposal, but by considering the allineations of the stars as seen in the sky and by comparing these with the data of the Paris chart, I found the latter frequently incorrect, not always by small amounts.

The configurations of the group of smaller stars are quite wrong in very many cases, even where all the stars are given; and very many stars are missing of a magnitude superior to the smallest included on the chart.

In particular, the following stars laid down on the Paris chart do not exist in the heavens:

R. A.  $10^h 3^m 52^s$ ;  $\delta + 13^\circ 17'.5$

10 40; 13 39

17 18; 13 30.5

18 4; 12 59

5 40; 12 4.0

5 42; 11 54

} Large double; only one of which exists.

10 12 39;  $+11 16.0$

The following stars (among others) are too small in the Paris chart:

R. A.	10 <sup>h</sup>	16 <sup>m</sup>	0 <sup>s</sup> ; $\delta + 12^\circ$	10'.0
		8	11 ; 12	42.5
		10	22 ; 12	42.0
		10	12 ; 12	23.5
		18	25 ; 12	56.5
		18	29 ; 12	51.5
	10	18	39 ; + 12	50.2

The following stars (among many others) are too large in the Paris chart:

R. A. 10<sup>h</sup> 10<sup>m</sup> 13<sup>s</sup>;  $+ 13^\circ$  27'.5. Paris 6<sup>m</sup>, really 9<sup>m</sup>  
 10 2 30 ;  $+ 11$  24.0. Paris 8<sup>m</sup>, really 9-10<sup>m</sup>,  
 and many others.

The configurations of the Paris chart are often quite wrong; perhaps the worst cases are at

R. A.	10 <sup>h</sup>	4 <sup>m</sup>	30 <sup>s</sup> -60 <sup>s</sup> ; $\delta + 10^\circ$	15'-25'.
	10	14	; + 11	30-45.

In every one of these cases the Hamilton College chart was correct; and after a careful examination of nearly every star on this latter chart I found only one case in which the chart seemed to me in the least erroneous. One faint star seemed to me about 1<sup>m</sup> too bright.

This chart was not only an accurate map of the stars, it was also a picture of them, and a configuration of stars in the sky would at once catch the eye on the map, and *vice versa*. It need hardly be said that this is not true of any other series of charts existing, not even of the maps of Argelander's *Durchmusterung*.

The explanation is not far to seek, and lies in the perpetual revision to which the Hamilton College charts have been subjected. It is only fair to say that this excellence would appear somewhat less striking if the charts were used in connection with a telescope different from that by means of which they were constructed. They would, in any case, remain the most admirable series now existing; and they would be of great value and would save much time and labor. For instance, in the observation of asteroids with the transit-circle of the Naval Observatory, much time is now wasted in finding the asteroid with the 9-inch equatorial. This amounts, in some cases, almost to a new discovery. If these maps were available at the Naval Observatory, this labor would be materially lightened. Astronomers are to be congratulated that Dr. Peters has decided to publish these beautiful charts.

Schoenfeld's *Durchmusterung* of all stars to the tenth magnitude, inclusive, from  $-2^\circ$  to  $-23^\circ$  of declination, is very nearly finished; 356,000 observations have been made, and the map of Hour XIII has been finished. It contains 4,233 stars. It is probable that the whole work will be finished by 1883.

For the convenience of those who are using star charts, the following

index to Chacornac's charts (including the later Paris charts) is presented :

No.	R. A.		Declination.		No.	R. A.		Declination.	
	<i>h. m.</i>	<i>h. m.</i>	<i>° ' "</i>	<i>° ' "</i>		<i>h. m.</i>	<i>h. m.</i>	<i>° ' "</i>	<i>° ' "</i>
1	0 0	to 0 20	+ 1 0	to - 4 15	32	10 20	to 10 40	+ 6 45	to +12 0
1a	0 0	0 20	+ 1 0	+ 6 15	34	11 0	11 20	+ 2 45	+ 8 0
2	0 20	0 40	- 1 45	+ 8 30	35	11 20	11 40	+ 0 30	+ 5 45
2 bis	0 20	0 40	+ 3 30	+ 8 45	36	11 40	12 0	- 1 30	+ 3 45
3	0 40	0 60	+ 6 15	+ 5 30	39	13 0	13 20	-10 30	- 5 15
3a	0 40	1 0	+ 6 30	+10 45	41	13 20	13 40	-12 0	- 6 45
4	1 0	1 20	+ 4 45	+10 0	43a	14 0	14 20	-10 30	- 5 15
5	1 20	1 40	+ 7 0	+12 15	46	15 0	15 20	-20 30	-15 15
6	1 40	2 0	+ 9 0	+14 15	49	16 0	16 20	-23 45	-18 30
7	2 0	2 20	+10 30	+15 45	50	16 20	16 40	-24 30	-19 15
9	2 40	3 0	+14 0	+19 15	51	16 40	17 0	-25 0	-19 45
13	4 0	4 20	+18 45	+24 0	52	17 0	17 20	-25 30	-20 15
15	4 40	5 0	+20 0	+25 15	60	19 40	20 0	-23 45	-18 30
22	7 0	7 20	+20 0	+25 15	61	20 0	20 20	-22 45	-17 30
26	8 20	8 40	+16 15	+21 30	62	20 20	20 40	-21 30	-16 15
27	8 40	9 0	+15 0	+20 15	63	20 40	21 0	-20 15	-15 0
28	9 0	9 20	+13 45	+19 0	64	21 0	21 20	-22 0	-16 45
29	9 20	9 40	+12 15	+17 30	64a	21 0	21 20	-16 45	-11 30
29a	9 20	9 40	+ 7 0	+12 15	70	23 0	23 20	- 8 0	- 2 45
30	9 40	10 0	+10 30	+15 45	71	23 20	23 40	- 5 45	- 0 30
31	10 0	10 20	+ 8 45	+14 0	72	23 40	24 0	- 3 45	+ 1 30

# DOUBLE STARS.

The long series of measures of double stars, made at Washington from 1875 to 1880, by Professor Hall, has been published separately. Professor Hall has made a complete series of observations of a selected list of doubles, selected by Dr. Struve and himself for comparison, and besides has investigated the angles and sides of a triangle and a quadrilateral of stars as measured and computed. The results of these measures are excellent. The double stars measured are very numerous, and are nearly all of interesting stars. A discussion of a two years' series of measures on the trapezium of *Orion* is given separately, adjusted by least squares.

The star  $\zeta$  *Canceri* is triple and has been well observed. Dr. Seeliger, of Leipzig, has investigated the orbits of the three stars, A, B, C, in a memoir, of which he has given a synopsis in the *Sitzungsberichte* of the Vienna Academy for May, 1881. Without giving details, we may state his principal results. He first finds an orbit for B about A, and this orbit satisfies the observations very well without taking into account the star C at all. This may arise from one of two things: either the influence of C is veritably small, or the perturbations by C occur in such a way as to compensate in their effects on the elements of the orbit of B and A. Dr. Seeliger has shown that the latter is the case. For the mass of C we can (arbitrarily) assume large values without destroying the agreement between observation and computation, and further, he has shown that a large value *must* be assigned to the mass of C. This has been shown in different and independent ways. The mass of C is larger than 2.4 times the sum of the masses of A and B.

The orbit of C is next investigated, and a suggestion of Dr. Otto Struve's that C moves round a dark body near it, is found to be highly probable. The final result of his discussion of this question is that it is

probable that C moves round a star which belongs to this system, but which is not one of the three known, A, B, C.

During the first part of 1881, Mr. S. W. Burnham was resident at the Washburn Observatory at Madison, by the invitation of Governor Washburn. During the period April 23 to September 30, 1881, he discovered 88 new double stars, several of great difficulty, and measured no less than 162 double stars (each on three nights) selected from his MS. Catalogue of Double Stars. In the zone observations at this observatory during the same period, 60 more double stars were found. Mr. Jedrzejewicz, of Plonsk, has published during the year a continuation of his double star measures, which appear to be remarkably consistent among themselves. He has measured a great many of the neglected pairs of Struve, each star on three or more nights.

The observations are given in the *Astronomische Nachrichten*, Nos. 2324-2407.

*Companion of Sirius*.—An orbit of the companion of *Sirius*, based on measures, has been computed by Professor Colbert, of Chicago.

The elements give the period as 49.6 years. The position for 1881.2 is  $p=45^{\circ}.6$ ,  $s=9''.9$ ; for 1882.2,  $p=43^{\circ}.1$ ,  $s=9''.5$ . For 1890.2 the position is  $p=322^{\circ}.2$ ,  $s=2''.2$ , and at that date *Sirius* will be about the most difficult known double. This is about the minimum, according to Professor Colbert.

#### THE SOLAR SYSTEM.

By far the most important papers which have appeared during the year are those of Mr. George Darwin on tidal friction in connection with the history of the solar system.\* This paper forms one of a series on the subject of tidal friction, which has been read from time to time before the Royal Society. An abstract of one of these was given in this report for 1880. The first part of this paper contains the investigation of the changes produced by tidal friction in the system formed by a planet with any number of satellites revolving about it in circular orbits. As the results cannot be conveniently stated without the aid of mathematical notation, they are here passed over.

The previous papers treated of the effects which tidal friction must have had on the motions of the earth and moon, on the supposition that time enough has elapsed for this cause to have its full effect. It then appeared that we are thus able to co-ordinate together the various elements of the motions of these two bodies in a manner too remarkable to be the product of chance.

The second part of the paper contains a discussion of the part which the same agency may have played in the evolution of the solar system as a whole and of its several parts.

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\* An account of a paper entitled "On the tidal friction of a planet attended by several satellites, and on the evolution of the solar system, by G. H. Darwin, F. R. S., read before the Royal Society on January 20, 1881."

It is first proposed that the rate of expansion of the planetary orbits, due to the reaction of the frictional tides raised by the planets in the sun, must be very slow compared with that due to the reaction of the tides raised by the sun in the planets. Thus it would be much more nearly correct to treat the sun as a rigid body, and to suppose the planets alone to be subject to frictional tides than the converse. It did not, however, seem expedient to attempt to give any numerical solution of the problem thus suggested, which should apply to the solar system as a whole. The effect of tidal friction is to convert the rotational momentum of the tidally-disturbed body into orbital momentum of the tide-raising body. Hence, a numerical evaluation of the angular momentum of the various parts of the solar system will afford the means of forming some idea of the amount of change in the orbits of the several planets and satellites which have been produced by tidal friction. Such an evaluation is accordingly made in this paper, with as much accuracy as the data permit.

From the numerical values so found, it is concluded that the orbits of the planets round the sun can hardly have undergone a sensible enlargement from the effects of tidal friction, since those bodies first attained a separate existence.

Turning to the several subsystems it appears that although it is possible that the orbits of the satellites of Mars, Jupiter, and Saturn about their planets may have been considerably enlarged, yet it is certainly not possible to trace the satellites back to an origin almost in contact with the present surfaces of their planets, in the same manner as was done for the case of the moon in the previous papers.

The numerical values above referred to exhibit so marked a contrast between the case of the earth with the moon, and that of the other planets with their satellites, that it might, *a priori*, be concluded as probable that the modes of evolution have differed considerably. The conclusion above stated concerning the satellites of the other planets cannot therefore be regarded as unfavorable to the acceptance of the views maintained in the previous papers. It must, however, be supposed that some important cause of change, other than tidal friction, has been conceived in the evolution of the solar system and the planetary subsystems. According to the nebular hypothesis of Laplace, that cause has been the condensation of the heavenly bodies. Accepting that hypothesis the author then proceeds to consider the manner in which contraction and tidal friction are likely to have worked together.

A numerical comparison shows that notwithstanding the greater age which the nebular theory assigns to the exterior planets, yet the effects of solar tidal friction in reducing planetary rotation must, in all probability, be considerably less for the remote than for the nearer planets. It is, however, remarkable that the number expressive of the rate of retardation of the Martian rotation by solar tidal friction is nearly the same as the similar number for the earth, notwithstanding the greater

distance of Mars from the sun. This result is worthy of notice in connection with the fact that the inner satellite of Mars revolves with a periodic time much shorter than that of the planets' rotation; for (as suggested in a previous paper) solar tidal friction will have been competent to reduce the planetary rotation without directly affecting the satellites' orbital motion.

It is, then, shown to be probable that solar tidal friction was a more important cause of change when the planets were less condensed than it is at present. Thus we are not to accept the present rate of action of solar tidal friction as indicating that which has been held true in all past time.

It is also shown that if a planetary mass generates a large satellite, the planetary rotation is reduced after the change more rapidly than before; nevertheless the genesis of such a satellite is preservative of the moment of momentum, which is internal to the planetary subsystem. This conclusion is illustrated by the comparatively slow rotation of the earth, and by the large amount of angular momentum residing in the system of moon and earth.

An examination of the manner in which the difference of distances, of the various planets from the sun will have affected the action of tidal friction, leads to a cause for the observed distribution of satellites in the solar system.

According to the nebular hypothesis a planetary mass contracts, and rotates quicker as it contracts. The rapidity of its revolution causes its form to become unstable, or perhaps, as seems more probable, an equatorial belt gradually detaches itself; it is immaterial which of these really takes place. In either case the separation of that part of the mass which before the change had the greatest angular momentum permits the central portion to resume a planetary shape. The contraction and increase of rotation proceed continually until another portion is detached, and so on. There thus recur at intervals a series of epochs of instability or abnormal change. Now, tidal friction must diminish the rate of increase of rotation due to contraction, and therefore if tidal friction and contraction are at work together the epochs of instability must recur more rarely than if contraction acted alone. If the tidal retardation is sufficiently great, the increase of rotation due to contraction will be so far counteracted as never to permit an epoch of instability to occur. The rate of solar tidal friction decreases rapidly as we recede from the sun, and therefore these considerations accord with what we observe in the solar system. For Mercury and Venus have no satellites, and there is a progressive increase in the number of satellites as we recede from the sun.

Whether this be the true cause of the observed distribution of satellites amongst the planets or not, it is remarkable that the same cause also affords an explanation of that difference between the tellurian system and the other planets with their satellites which has permitted tidal

friction to be the principal agent of change with the former, but not with the latter.

In the case of the contracting terrestrial mass we may suppose that there was for a long time nearly a balance between the retardation due to solar tidal friction and the acceleration due to contraction, and that it was not until the planetary mass had contracted to nearly its present dimensions that an epoch of instability could occur. If the contraction of the planetary mass be almost completed before the genesis of the satellite, tidal friction, due jointly to the satellite and the sun, will thereafter be the great cause of change in the system, and thus the hypothesis that it is the sole cause of change will give an approximately accurate explanation of the motion of the planet and satellite at any subsequent time. It is shown in the previous papers of this series that this condition is fulfilled with the earth and moon.

The paper ends with a short recapitulation of those facts in the solar system which are susceptible of explanation by the theory of the activity of tidal friction. This series of investigations affords no grounds for the rejection of the nebular hypothesis, but while it presents evidence in favor of the main outlines of that theory it introduces modifications of considerable importance.

Tidal friction is a cause of change of which Laplace's theory took no account, and although the activity of that cause is to be regarded as mainly belonging to a later period than the events predicated by the nebular hypothesis, yet its influence has been of great and in one instance of even paramount importance in determining the present condition of the planets and their satellites.

#### THE SUN.

The publication of Professor Young's book on the sun (International Scientific Series), in 1881, is important, as it is undoubtedly the authority on the subject, and supplements the work of Secchi, and presents, beside, more philosophical and extended views.

The first chapters deal with the dimensions and distance of the sun, with the means and apparatus for studying its surface, with the phenomena of sun spots, their periodicity, etc.; with the phenomena of solar eclipses, the corona, etc. Perhaps the two most important chapters are those relating to the sun's light and heat, and the different theories relating to the constitution of the sun. The theory of Dr. Hastings, spoken of in the last report of the Smithsonian Institution, receives a discussion to which we must refer. In an appendix, Professor Langley gives an account of his observations with the bolometer, and the conclusions he has derived from them. To test these conclusions still further, Professor Langley undertook an expedition to the western part of the United States, which is anticipated by Gibbon, in chapter 43 of the "Decline and Fall of the Roman Empire," in the following words: "Their calculations may perhaps be verified by the astronomers of some future capital in the Siberian or American wilderness."



Professor Langley's expedition started in July, 1881, and took up a station on Mount Whitney, in the Sierras, where observations were made to determine the amount of solar heat received by the earth. This was the main object of the expedition. Several minor researches of interest were also prosecuted; among others, an attempt was made to see the sun's corona and *Vulcan*. It is too soon as yet to speak of the results of the expedition, which have not been published.

*Statistics of the sun.*—The following statistics of the sun, comprising facts which can be stated in numbers, are selected from Professor Young's work, "The Sun":

Solar parallax (equatorial horizontal),  $8.80'' \pm 0.02''$ .

Mean distance of the sun from the earth, 92,885,000 miles, 149,480,000 kilometres.

Variation of the distance of the sun from the earth between January and June, 3,100,000 miles, 4,950,000 kilometres.

Linear value of  $1''$  on the sun's surface, 450.3 miles, 724.7 kilometres.

Mean angular semi-diameter of the sun,  $16' 02.0'' \pm 1.0''$ .

Sun's linear diameter, 866,400 miles, 1,394,300 kilometres. (This may, perhaps, be variable to the extent of several hundred miles.)

Ratio of the sun's diameter to the earth's, 109.3.

Surface of the sun compared with the earth, 11,940.

Volume, or cubic contents, of the sun compared with the earth, 1,305,000.

Mass, or quantity of matter, of the sun compared with the earth, 330,000  $\pm$  3,000.

Mean density of the sun compared with the earth, 0.253.

Mean density of the sun compared with water, 1.406.

Force of gravity on the sun's surface compared with that on the earth, 27.6.

Distance a body would fall in one second, 444.4 feet, 135.5 meters.

Inclination of the sun's axis to the ecliptic,  $7^\circ 15'$ .

Longitude of its ascending node,  $74^\circ$ .

Date when the sun is at node, June 4-5.

Mean time of the sun's rotation (Carrington), 25.38 days.

Time of rotation of the sun's equator, 25 days.

Time of rotation at latitude,  $20^\circ$ , 25.75 days.

Time of rotation at latitude,  $30^\circ$ , 26.5 days.

Time of rotation at latitude,  $45^\circ$ , 27.5 days.

(These last four numbers are somewhat doubtful, the formulæ of various authorities giving results differing by several hours in some cases.)

Linear velocity of the sun's rotation at his equator, 2.261 miles per second, 2.028 kilometers per second.

Total quantity of sunlight, 6,300,000,000,000,000,000,000,000,000 candles.

Intensity of the sunlight at the surface of the sun, 190,000 times that of a candle flame, 5,300 times that of a metal in a Bessemer converter, 146 times that of a calcium light, 3.4 times that of an electric arc.

Brightness of a point on the sun's limb compared with that of a point near the center of the disk, 25 per cent.

Heat received per minute from the sun upon a square metre, perpendicularly exposed to the solar radiation at the upper surface of the earth's atmosphere (the solar constant), 25 calories.

Heat radiation at the surface of the sun, per square metre per minute, 1,117,000 calories.

Thickness of a shell of ice which would be melted from the surface of the sun per minute,  $48\frac{1}{2}$  feet, or  $14\frac{3}{4}$  meters.

Mechanical equivalent of the solar radiation at the sun's surface, continuously acting, 109,000 horse-power per square metre; 10,000 (nearly) per square foot.

Effective temperature of the solar surface (according to Rosetti), about  $10,000^{\circ}$  Cent., or  $18,000^{\circ}$  Fahr.

#### SOLAR PARALLAX.

Mr. David Gill, Her Majesty's astronomer at the Cape of Good Hope, has just issued, as a reprint from the forty-sixth volume of the "Memoirs of the Royal Astronomical Society," his definitive paper on the determination of the solar parallax from observations of Mars at Ascension in 1877. We think it no exaggeration to style it the most important separate determination of this constant which has ever been made. In Mrs. Gill's charming little book, "Six Months in Ascension: An Unscientific Account of a Scientific Expedition," the incidents and details of a somewhat arduous undertaking, now become historic, were fully described. The expenses of the expedition were defrayed by vote of the Council of the Royal Astronomical Society in the first instance, and later from the Government Grant Fund of the Royal Society. The observations at Ascension were made with the heliometer owned by Lord Lindsay (now the Earl of Crawford and Balcarres), in accordance with what astronomers call "the method of the diurnal parallax," or "east-and-west method." While much of the detail of reduction of the work is presented in Mr. Gill's admirable volume, a vast deal has been omitted in the printing—in full accord with the more advanced and advancing notions on this subject. The original note-books and manuscripts are deposited with the society, where they may, and should, be referred to, if the re-examination of the work is ever undertaken, or any doubtful point arises. The final result of Mr. Gill's investigation is  $8''.78$ , with a probable error of  $0''.012$ —which gives, for the mean distance of the earth from the sun, 93,080,000 miles. Most astronomers will have little doubt that this value of the solar parallax is too small; nevertheless, the more important of the recent researches on this subject show this value to be a close approximation to the truth.

M. Faye has just communicated to the French Academy a paper on the actual state of our knowledge of the sun's parallax.

He considers that there is no other scientific constant, the determina-

tion of which depends on an equal number of results completely independent of one another, and obtained by methods so totally different, and subdivides the various values assigned for the sun's mean parallax as follows:

Geometrical methods,  $8''.82$ :

$8''.85$  by Mars (Cassini's method), Newcomb.

$8''.79$  by Venus, 1769 (Halley's method), Powalky.

$8''.81$  by Venus, 1874 (Halley's method), Tupman.

$8''.87$  by Flora (Galle's method), Galle.

$8''.79$  by Juno (Galle's method), Lindsay.

Mechanical methods,  $8''.83$ :

$8''.81$  by the lunar inequality (Laplace's method), Newcomb.

$8''.85$  by the monthly equation of the earth, Leverrier.

$8''.83$  by the perturbations of Venus and Mars, Leverrier.

Physical methods,  $8''.81$ :

$8''.799$  velocity of light (Fizeau's method), Cornu.

$8''.813$  velocity of light (Foucault's method), Michelson.

After explaining the value of the different results, M. Faye gives his preference to the physical result, and arrives at these conclusions:

1. That the method of the physicists is superior to all others, and ought to be substituted.

2. That the value of solar parallax,  $8''.813$  (by physical methods), is now determined to about  $\frac{1}{10}$  of a second.

3. That the seven astronomical methods of procedure converge more and more toward that value, and tend to confirm it without equalling it in precision.

In other words, M. Faye believes that the true distance of the sun is that found recently by Mr. Michelson.

Professor Eastman has published "A Value of the Solar Parallax from Meridian Observations of Mars at the Opposition in 1877." In 1876 a circular letter, was prepared at the Naval Observatory and distributed to astronomers, asking their coöperation in making meridian observations of *Mars* in 1877. A programme of observing was proposed by Professor Eastman, based on that suggested by Dr. Winnecke in 1862, and a list of comparison stars was selected. The programme was strictly followed at Washington, at Sydney, and partly at Leyden. At Melbourne, the Cape of Good Hope, and Cambridge, Mass., the programme was not followed; and from San Fernando and Kremsmunster observations were received either unreduced or unexplained. Professor Eastman has not reduced the San Fernando observations and makes no use of those at Kremsmunster. The observations of *Mars* when less than four comparison stars were used on any night, are also rejected. Upon the remainder, the discussion is made.

The probable error of a single declination of *Mars* was found to be—

At Washington.....  $\pm 0''.452$

At Melbourne.....  $\pm 0''.552$

At Leyden.....  $\pm 0''.311$

The probable error of a single declination of a comparison star was found to be—

At Washington .....	$\pm 0''.302$
At Melbourne .....	$\pm 0''.349$
At Leyden .....	$\pm 0''.255$

It may be said in passing that the precision of the Leyden results is undoubtedly due to the method of observation (two observers taking part in it), and also to the thorough way in which the constants of the Leyden circle were investigated by Kayser. The reduced observations are compared two and two for determinations of the parallax :

Washington and Melbourne;  $\pi = 8''.97 \pm 0''.03$ .

Washington and Sydney;  $\pi = 8''.88 \pm 0''.05$ .

Washington and Cape of Good Hope;  $\pi = 8''.90 \pm 0''.07$ .

Melbourne and Leyden;  $\pi = 8''.97 \pm 0''.03$ .

Melbourne and Cambridge;  $\pi = 9''.14 \pm 0''.05$ .

In all, these include 70 determinations, and give for the value of  $\pi$ ,  $8''.980 \pm 0''.017$ . Professor Eastman rejects the Cambridge observations and also certain separate observations; the result from 60 determinations is  $\pi = 8''.953 \pm 0''.019$ , which is adopted.

Professor Eastman says "the method of determining the solar parallax from meridian observations of *Mars*, has never had a fair trial. The principal obstacle to be overcome is the desire of each observatory to co-operate in its own way, if at all, thereby wasting its own work and rendering good observations at other stations useless," and he urges "that at the next favorable opposition of *Mars*, astronomers may rise above all jealousies and prejudices, and unite upon some plan to give this method one fair trial before it is condemned." The results of Professor Eastman's discussion, and of that of Dr. Winnecke, in 1862, are in so good agreement that the method certainly deserves, and undoubtedly will obtain, another trial.

The next favorable opposition will occur in 1892, and this interval will give all "jealousies" a chance to cool. Mr. Gill has suggested a reason why the results from *Mars* observations differ systematically from those by other methods, which is considered by Professor Eastman, on p. 43 of his memoir, and it certainly seems that the experiments of Professor Eastman (which are still in progress) invalidate the proposed explanation. This is a point upon which further light is much needed.

*Transit of Venus, 1874.*—The United States Transit of Venus Commission published a volume containing the chief results of measurements of the photographs of the transit of Venus parties sent out by the United States in 1874. No definitive result for the parallax was given, as some elements for the determination of the final value were still wanting. Professor Todd, director of the Amherst College Observatory, has discussed these observations as they stand, and has obtained values for the solar parallax which are probably very near the final values. From

the photographs at the following northern stations, Wladiwastok (13), Nagasaki (45), Peking (26), and from those at southern stations, Kerguelen (8), Hobartown (37), Campbelltown (32), Queenstown (45), Chatham Island (7), Mr. Todd finds the solar parallax from measured angles of position on the photographs of the Sun and *Venus*,  $\pi = 8''.873 \pm 0''.060$ ; from measured distances,  $\pi = 8''.888 \pm 0''.040$ ; and finally, having regard to the weights,  $\pi = 8''.883 \pm 0''.034$ .

*Velocity of light.*—An experimental determination of the velocity of white and colored light formed the subject of a memoir, the joint production of Dr. J. Young and Prof. G. Forbes, read before the Royal Society, London, lately. The official summary states that the method employed was that of Fizeau, but instead of using one distant reflector and observing the total eclipse of the reflected ray by a toothed revolving wheel, two reflectors nearly in the same line with the observing telescope and one a quarter of a mile behind the other were used, and the rays were viewed when brought to equal brightness by means of the adjustment of the speed of the wheel. The general result was that the velocity of the light of an electric lamp is 187,200 miles per second. Cornu found that of the light of a petroleum lamp to be 186,700 miles per second, and Michelson that of the sun to be 186,500 miles per second. The higher number of Young and Forbes is possibly due to the bluer light of electricity, for further experiments made with colored lights and the spectrum tended to prove that the blue light probably travels faster by 1 per cent. than the red light. The experiments were made at Wemyss Bay, Scotland.

The results of Forbes and Young have, we believe, not been accepted as yet by physicists. From theoretical considerations, Lord Rayleigh and Mr. Michelson, among others, have shown the improbability of these figures for the velocity of light of different colors.

*Transit of Venus December 6, 1882.*—In view of the fact that many of the readers of this report will have an opportunity to observe the next transit of Venus we present the instructions issued by the International Conference for the observation of the transit of Venus of 1862.

"Article 1. It is desirable, from a theoretical stand-point, that the telescope used should be of as large aperture as possible. In practice, the difficulty of transportation on the one hand, and the necessity of observers at different stations having similar instruments, limits the apertures to from 0.12 meter to 0.15 meter (about  $4\frac{1}{2}$  to 6 inches.)

In all cases the objectives should be as perfect as possible. Observers should give an exact description of the quality and defects of the objective, as also the eye-piece employed. Towards this end they should determine:

1. The form of the image of a star in focus, as also the image of the same star at a point before and after coming into focus.
2. The separating power of the objective for double stars.

It will be useful to know, also, if the telescope is able to show the solar granulations on any favorable opportunity, and also the degree of visibility of these granulations during the transit.

*Art. 2.* It will be well to employ a reflecting prism, or a polariscopic eye-piece, to diminish the heat and consequent danger to the observer's eyes.

If it be decided to use a silvered objective, a method which offers the great advantage of eliminating all the obscure heat rays and doing away with errors from distortion arising from heating of the interior of the tube, the excess of light may be absorbed by a neutral tint glass composed of two glasses of similar thickness, one being colored and the other colorless.

*Art. 3.* The eye-pieces should be positive, achromatic, and of a power of 150. The observations of contacts should be made in a field sufficiently clear to show, plainly projected on the solar disc, two wires separated by a distance of 1".

Means should be employed to remove as far as possible the effects of atmospheric dispersion.

The setting-point of the reticule should be previously ascertained on the stars, or by means of a collimator focused to stars.

In cases of observation by projection, corresponding means should be employed.

*Art. 4.* The times corresponding to internal contacts may be defined as follows:

*Ingress:* The moment when an evident and, at the same time, persistent discontinuity in the illumination of the apparent limb of the sun jointing the point of contact with Venus disappears.

*Egress:* The moment of the first appearance of an evident and, at the same time, persistent discontinuity in the illumination of the solar limb joining the point of contact.

If the limb of two stars coming into geometrical contact, without obscuration or deformation of the interposed thread of light, the instant previously defined is that of contact.

If there be produced a black drop or ligament, well defined and as dark as the body of the planet, the precedingly defined instants are: for ingress, that of definite rupture; and for egress, that of the first apparition of the ligament.

Between these two extreme cases, other appearances may be produced when the instants of contact may be noted as follows:

If, the limbs remaining without deformation, there is produced an obscuration of the luminous thread, without the shadow, however, being as dark as the body of the planet, the observer notes the instant of geometrical contact. The moment of the formation or disappearance of this shadow should also be noted.

If the shadow is almost or becomes quite as dark as the planet, the

precedingly defined instant is that when this equality ceases or is established.

The observer should also note whether there is produced on the luminous thread any fringes or any other distinct phenomena, and should note the moment of their appearance and disappearance.

It is generally desirable to note the time of occurrence of any distinct phenomena about the time of contact. Nevertheless it is a grave mistake, and one that should be guarded against, to multiply the noting of times near the occurrence of a contact.

The time of appearance of phenomena of a distinct character should be mentioned only in such a manner as to be readily separated from other phenomena observed about contact.

It will be useful in all cases that the observer should illustrate his notes with a drawing made immediately after each complete observation of contact, in order to show more clearly the interpretation which he attaches to his description of the phenomena.

*Art. 5.* As the limb of Venus falls internally on the solar disc during internal contact, as has been noted in Article 4, the observer should indicate as closely as possible whether the moment when the limbs of Venus and the sun, apparently coinciding, seem to be lengthened out.

This observation, though rough, is still desirable as a check to the principal noted phase.

*Art 6.* Notwithstanding the fact that observations of external contacts are subject to considerable uncertainty, the conference recommends that they be observed either by direct vision or by means of the spectroscope, and that the point on the solar disc, where the first contact takes place, be determined in an appropriate manner." *Comptes Rendus, October, 1881.*

The Austrian Government will be petitioned to grant a subvention towards equipping an expedition to take part in the observation of the next transit of Venus, on 6th of December, 1882, as the next opportunity of thus measuring the distance of the earth from the sun will not occur till the year 2004. The Bermudas are recommended as the most suitable observation station.

*Transit of Mercury, November 7, 1881.*—A noteworthy fact in relation to this transit is the expedition of Mr. C. H. Rockwell to the Sandwich Islands for the purpose of observing it. Only two contacts could be seen in the United States, and so Mr. Rockwell left his observatory at Tarrytown and arrived at Honolulu on November 4. On November 7 he observed all four contacts and a number of differences of R. A. of the sun and Mercury, and on the 8th sailed for the United States.

The only other American observation of which we know was made at the new Lick observatory by Prof. E. S. Holden and Mr. S. W. Burnham, who observed the first and second contacts.

The transit was well observed in Australia.

COMETS.

The following is a list of the comets of the year 1881 in the order of their discovery:

Comet A....	Swift .....	Rochester, N. Y.
Comet B....	Tebbutt .....	South Africa.
Comet C....	Schaeberle .....	Ann Arbor, Mich.
Comet D....	Encke's .....	(Periodic and expected.)
Comet E. . .	Barnard.....	Nashville, Tenn.
Comet F....	Brooks . . . . .	Phelps, N. Y.
Comet G....	Swift .....	Rochester, N. Y.

Comet A was found May 1 in *Andromeda*. It was a faint object, and, moving rapidly southeast, was soon lost in the morning twilight, and was not seen in the southern hemisphere.

Comet B was the brightest since the memorable one of 1861. Its path was nearly due north, and by its proximity to the sun was soon rendered invisible from any part of the world. It passed the sun at noon on June 19, and was first seen in the northern hemisphere on the morning of June 22, its tail only then being visible. The next morning it became an object of general observation. Its subsequent career is too well remembered to need a description here. Its orbit is probably elliptical, having a period of about 3,000 years. From a similarity of elements it was at first thought to be the comet of 1807.

Comet C was first seen on the morning of July 18, somewhat singularly, in almost the same place where comet B had so suddenly appeared after having been lost sight of in the southern hemisphere. Like B it had two tails. Its elements are unlike those of any comet heretofore observed.

Comet D (Encke's), which has a period of only about  $3\frac{3}{4}$  years, has just paid us the twenty-ninth visit since it was first detected in 1786.

Comet E was discovered on August 18 by Mr. E. E. Barnard. It moves in a parabolic orbit.

Comet F was first detected on the morning of October 4 by Mr. W. R. Brooks, and on the next morning by Mr. W. F. Denning, of Bristol, England, who immediately announced it, which Mr. Brooks for two days failed to do, as clouds prevented him from determining whether it were a comet or a nebula. It is, notwithstanding that it was visible only through the telescope, by far the most important one of the year. It is a periodic comet of the short period of eight years. It is, therefore, and probably for years has been, a permanent member of our system.

Comet G, discovered by Swift on the evening of November 16, is of fair size, though faint, and, like A, E, and F, without a tail. Its elements are somewhat like those of comet A, 1792.

Comet B was successfully photographed by several astronomers—notably by Prof. Henry Draper and Dr. Huggins—a feat never before



accomplished. Several small stars were shown on the negative, shining through the tail, though their light passed through probably 100,000 miles of cometic matter. This shows the exceeding transparency of these bodies.

*Comet B, 1881.*—An important note on the photographic *spectrum* of comet B, 1881, has been sent to the Royal Society, London, by Dr. Huggins. After subjecting the plate to an exposure of one hour with the nucleus of the comet acting through one-half of the slit of the apparatus (see for process "Philosophical Transactions of 1880," page 769), the open half was closed, the shutter withdrawn from the other half and the instrument then directed to Arcturus for 15 minutes. The result was a very distinct spectrum of the comet, together with the spectrum of the star. The spectrum of the comet consists of a pair of bright lines in the ultra-violet region and a continuous spectrum which can be traced from about F to some distance beyond H. The obvious inference he makes from the position and measurement, in wave lengths, of the lines is that part of the light of comets emanates from themselves, and that part of their light is simply reflected sunlight. Further, the spectrum would go to prove the presence of carbon in the substance of comets, possibly in combination with hydrogen. Another photograph was taken on June 25, when the plate was exposed for an hour and a half, but it was so faint that the Fraunhofer lines could not be seen in the continuous spectrum, although they were clearly observable in the former photograph. But the two bright lines were very distinct. Subsequently, on July 9, he found the wave lengths of the two bright lines to be 3,883 and 3,870, and discovered that the less refrangible threw a faint luminosity beyond the second line. He saw, too, the groups of lines between G and h usually associated with the carbon compounds. His wave length for the less refrangible end of the spectrum is 4,230. Nitrogen would seem, also, to be present in the comet, besides carbon and hydrogen. Dr. Huggins concludes: "It is of importance to mention the strong intensity in the photograph of the lines 3,883 and 3,870, as compared with the continuous spectrum, and the faint, bright group beginning at 4,230. At this part of the spectrum, therefore, the light emitted by the cometary matter exceeded by many times the reflected solar light.

This bright comet was also successfully photographed by Dr. Henry Draper in New York. The tail is  $8^{\circ}$  long on the picture, the exposure of the negative plate having been three hours. Spectroscopic observations of the *nucleus* showed a continuous spectrum, with no absorption lines (due to the coma) visible. The *tail*, also, gave a continuous spectrum without lines. The *coma* gave a banded spectrum, showing it to be gaseous.

This object has yielded unparalleled opportunity for research on the physical constitution of comets. It has been abundantly photographed by Draper and Common, and a series of drawings has been made by

Holden. A thorough optical examination of the comet's spectrum has been made by Young, Harkness, and Pickering. The spectrum has been photographed by Draper and Huggins. The light of different parts of the comet has been photometrically determined by Pickering, the results being expressed in stellar magnitudes on Pogson's logarithmic scale, showing the comet to be of the seventh magnitude very near the nucleus, and the tail, at  $4^{\circ}$  from the nucleus, to be of the 11.6 magnitude. And, lastly, the polarization of the comet's light has been observed by Wright, establishing the fact that the light emitted by the tail is polarized rather strongly in a plane passing through the sun's place, the percentages indicating that reflected sunlight constitutes the greater part of the light of the tail.

Professor Stone and his assistant, of the observatory at Cincinnati, saw this comet "separate before their eyes, forming a double comet." It is well known that Biela's comet did separate, but no observer actually saw the process, which, it is safe to say, must have been very gradual.

The observations of Professor Stone were doubted by Mr. Rock at the Naval Observatory at Washington, who was observing the comet at the same time, and the question was unsettled for the time.

It has since appeared that Mr. Wendell, of Harvard College Observatory, saw the nucleus double on one occasion, and at the Washburn Observatory the nucleus was seen double on several nights, by Professor Holden and Mr. Burnham, and on one night a perfectly satisfactory measure of the two parts was made by Mr. Burnham.

From a note furnished to the Harvard College Library Bulletin, by the observatory, the following is extracted:

"Much attention has been paid to cometary astronomy during the past summer at the observatory by Messrs. S. C. Chandler, jr., and O. C. Wendell. Orbits and ephemerides for four of the comets of the year have been computed within a few days of their discovery in the northern hemisphere, and circulated among astronomers by means of the telegraphic cipher devised by Messrs. Chandler and Ritchie. These results were largely derived from the observations of position made at the observatory. Professor Pickering has made many photometric observations of the brighter comets of the year.

"The spectrum of Comet B (the great comet which appeared towards the end of June) was shown by European observations to contain five bands, three of which are familiar in cometary spectra, while the other two seemed new. It appears probable that these two are identical with two of the three bands found last winter, at the observatory, in the peculiar spectrum of a star in *Canis Major*, Ll. 13,412, the third band being apparently due to hydrogen. An interesting analogy between the spectra of comets and stars is greatly strengthened by this observation, since the three familiar bands of cometary spectra were previously taken to agree with the bands seen in the spectra of a small class of stars, designated by Secchi as stars of the fourth type."

*Comet of 1861.*—The orbit of the great comet of 1861 has been thoroughly investigated by Herr Kreutz of Bonn, from 1,150 observations, which extend over nearly a year. During this period the comet traversed an arc of  $155^\circ$  of its orbit. Dr. Seeling had previously published an orbit (an ellipse of four hundred and nineteen years), with which the observations were compared. Thirty-one normal places (1861, May 28; 1862, April 23) were formed. Planetary perturbations were computed for the whole interval, and the effects of Venus, Earth, Jupiter, and Saturn were alone sensible. The perihelion passage was, 1861, June, 11.54 Berlin mean time, and the period comes out  $409.40 \pm 0.37$  years.

The small probable error of the period is noteworthy. Herr Kreutz is continuing his researches on this comet.

*Faye's Periodic Comet.*—The British Royal Astronomical Society, at its recent annual meeting, presented its gold medal to Prof. Axel Moller, director of the Observatory at Lund, in Sweden, for his investigations on the motion of Faye's comet. Professor Moller's researches commenced in 1860, soon after attention had been directed to this comet by the offer of a prize for the accurate determination of its orbit by the Society of Natural Sciences of Dantzic, and they have been continued to the present time, the comet's track at each of the three subsequent returns in 1865-'66, 1873, and 1880-'81 having been predicted with a precision which has excited in no small degree the admiration of astronomers; indeed, at the reappearance in 1873, M. Stephan's first observation at the Observatory of Marseilles showed that the error of predicted place was less than six seconds of arc, and after the last revolution, when the perturbations from the action of the planets were greater than in any previous revolution since the comet was first detected by M. Faye, in 1843, the agreement between observation and calculation was still very close. One important result of these investigations has been a striking confirmation, from the motion of Faye's comet, of the value for the mass of Jupiter deduced, by Bessel, from the elongations of the satellites, the two values according within the limits of their probable errors.

In January, 1881, Mr. H. H. Warner, of Rochester, N. Y., founder of the Warner Observatory, announced a prize of \$200 in gold to any American or Canadian who, during the year, should discover a telescopic unexpected comet. When comet B, or the great comet, was discovered, effort was made to ascertain who first saw it, and had a conclusion been possible among the thousands of claimants, a special prize would have been given. As none could be reached, Mr. Warner determined to give a special prize of \$200 for the best essay on "Comets, their Composition, Purpose, and Effect on the Earth." One hundred and twenty-five essays were sent in to Director Swift, of the Warner Observatory, and after a careful review, the judges—Prof. Elias Colbert of Chicago, Ill., Prof. H. A. Newton of Yale College, New Haven, Conn., and Prof. H.

M. Parkhurst of New York City—unanimously awarded the prize to the essay signed “Hipparchus III,” by Prof. Lewis Boss, director of the Dudley Observatory, of Albany, N. Y. The text of this essay has been published by the Rochester Astronomical Society.

Although the following extract is not of direct scientific interest, it is not without value as showing the official view of comets in China. It is dated July 4, 1881, at Peking:

“(1) A decree. For several days past a comet has been visible in the northwest, which We reverently take to be a warning indication from Heaven and accept with feelings of the deepest and most respectful awe. At the present time there are difficulties of many kinds to contend against, and the people are not at ease. It only remains for Ourselves and Our Ministers mutually to aid each other in the maintenance of an attitude of reverential watchfulness, cultivating a spirit of virtue, and examining Our shortcomings in the hope of invoking blessings and harmonious influences from Heaven, and securing comfort to the black-haired race. Do all ye Ministers at Our Court then, each and all strive to be diligent in the exercise of your respective functions, and with all your might put away from you the habits of perfunctoriness so long indulged in, assisting Us with true sincerity of heart, and uniting in a common effort to rescue your country from her difficulties. All provincial high authorities must positively attempt to compass this object by genuine endeavour, and set to work in earnest to bring about reforms, seeking out the afflicted and the sorrowful in the villages and hamlets, and ministering to their comfort with their whole heart. Then it may be that as each day goes by perfection may be more nearly attained. Let them thus endeavour to second Our earnest feeling of reverential awe and Our wish, by the cultivation of virtue and habits of introspection, to acknowledge this sign from Heaven by deeds and not mere empty words.”

*The August shooting-stars.*—Over a hundred systems of meteors, which are so disturbed by the passage of the earth near them on its way around the sun that “shooting-stars” are drawn from them into the earth’s atmosphere, where they are heated to visibility, are now known to astronomers. Most of these systems are unimportant because of their small size or comparatively great distance; and of the rest, only those which send us the August and November meteors are of particular interest, although those of the latter part of April, the early part of December, and the middle of July have been pointed out as noteworthy. It is a common theory of “shooting-stars” that they are the broken remnants of comets whose orbits once crossed or came near to that of the earth, but it is perhaps a mistake to hold that they are such débris, since all that is known of them touching this matter is that they often follow in the trains of comets as attendants. This is true of some well-known systems, but it has never been shown that *every* system of meteors thus follows in the wake of comets or that *every* comet is attended by shooting-stars. Of these bodies two interesting theories were proposed in

1879—one by Dr. Ball, the astronomer royal for Ireland, and the other by M. Stanislas Meunier, of whom a commission of the Paris Academy said that he was justified in concluding “that all these masses once belonged to a considerable globe like the earth, having true geological epochs, and that later it was decomposed into separate fragments under the action of causes difficult to define exactly, but which we have more than once seen in operation in the heavens themselves.” Dr. Ball’s theory is founded on the arguments which induced Tschermak to believe that he had proved meteorites to have no connection with shooting-stars, but to have their origin in volcanic eruptions in other planets so small that projectiles from them would not be driven back by the force of gravity. On the smallness of such planets Dr. Ball lays no stress, and indeed he first considered whether or not our meteorites may not come from the sun, rejecting this theory, however, on the ground that such solid rock masses as occasionally fall could hardly exist in such a body as the central source of heat. The sun failing, Dr. Ball turns to the moon, which also he rejects as a possible source, since, although it once might have thrown out meteoric masses, they would either fall at once to the earth or back upon the moon, or missing the earth would continue to travel round it, and probably in the course of centuries return to their original source. We must then assume that in her present cold state our satellite is continually throwing out bodies from active volcanoes—a supposition which no selenographer will entertain for a moment. For very good physical reasons Dr. Ball rejects also the different planets as sources of aerolites, and holds that they have had their origin on the earth itself, which, though in its present geological state it has no power to expel bodies with so great a velocity as his theory requires, yet was certainly once possessed of volcanoes which might have performed the work of throwing out matter with velocity enough to carry them beyond terrestrial influence and send them in orbits of their own around the sun, crossing at each revolution the point at which they were shot from the earth’s orbit. If this be true, showers of meteors should occur whenever the earth chanced to reach a point where a meteoric track crossed hers, and the aerolites would come back to their source.

At about the same time when Dr. Ball was elaborating this theory astronomers were following the researches of Daubrée, which seemed to indicate a likeness in physical characteristics between meteorites and the lower rock strata of the earth. M. Meunier, who was a pupil of Daubrée, found that this analogy had not to do alone with mineralogical constitution, but “extended to the relation which these cosmical materials disseminated in space present when compared among themselves as we compare the constituent rocks of our globe.” His conclusion, as given above, was that the meteorites, therefore, came from a “considerable globe like the earth,” having geological epochs analogous to ours, but now broken up and disseminated through space, as at some time our own globe may be. Notwithstanding the way in which this

latter theory was received by the Academy, it seems to be inadmissible when the dynamics of the present solar system and the doctrine of probabilities are called into play. On the other hand, if in the place of the "considerable globe like the earth" we substitute, with Dr. Ball, the earth itself, with its past certainties of enormous volcanic energy, then the theory may have some plausibility.

#### PLANETS.

VULCAN (?)—Dr. Swift, of Rochester, has announced his intention of going to Africa to observe the total eclipse of the sun on May 16, 1882. His special object is to look for the two intramercorial planets which appeared in the field of his telescope at Denver during the eclipse of 1879.

THE EARTH, *geodesy, etc.*—In the volume of the *Comptes Rendus* for 1880 of the International Geodetic Association for the measures of degrees in Europe, there is a remarkable map which shows at one glance the triangulation of Europe. To be fully appreciated, the original work must be consulted.

*The origin of the English mile.*—At a recent meeting of the French Academy of Science, a paper on a question of ancient metrology and the origin of the English mile was read by M. Faye. He inquires into the cause of the error, long current, of supposing the mile equivalent in length to a terrestrial arc of one minute. The mile has been probably deduced from Ptolemy's measure, and the error of one-sixth seems to arise from the English geographers having supposed that Ptolemy used the Greek foot, which Eratosthenes used 400 years before, whereas he used the Phileterian foot, which is about  $0.36^m$ , the earlier one being  $0.27^m$ . Eratosthenes counted 700 stadia to a degree; Ptolemy only about 500.

The evaluation of Ptolemy, M. Faye concludes, is merely a sort of conversion of the excellent measure of Eratosthenes into units of another epoch and different length. It must have lost, thus, a little of its first precision; but, as presented by Ptolemy, the English geographers had good reason to take it as base of an evaluation of the arc of one degree, and to offer it to nautical men of their country. Only, and here is the mistake, they believed that the great Greek astronomer used the Greek foot. This is one hundredth and a half more than the English foot. If the English geographers of the sixteenth century forced this evaluation but a little and carried it to five hundredths, they would have found 630 English feet to the stadium, which they believed to have 600 Greek feet, and these 630 feet, or these 210 yards, multiplied by 500, would have given them 105,000 yards for the degree, and exactly 1,760 yards to the mile. The English mile then has probably been deduced from the measure of Ptolemy; its error of one-sixth is due simply to confounding the Greek foot with the Phileterian foot.

Hence the mile of 1,609 meters long passed as equivalent in length

to a terrestrial arc of one minute—the degree containing sixty of these miles—when in reality it contains 69.5, the error being about one-sixth. This error delayed for many years the discovery of universal attraction. The first time the idea that the attraction of the earth retaining the moon in its orbit is the same thing as gravity, presented itself to Newton, he failed in the verification, because he then employed the mile in calculating the earth's radius. He thought he must renounce the idea, and he only returned to it when he became acquainted much later with the measurement of a degree executed by Picard, of France.

*The Moon.*—M. Janssen has succeeded in photographing the *lumière cendrée* or “earthshine” on the moon when three days old. In the photograph the “continents” were to be distinguished clearly from the “seas.”

**ASTERIODS.**—From the *Berliner Jahrbuch* for 1883 the following is extracted:

Column I contains the numbers of the minor planets in the order of discovery. Column II contains the *mean* magnitudes of the corresponding planets, and column III contains the means of the magnitudes of these planets at the times of their discovery. This table is a summary of a more extended one where these quantities are given for each asteroid separately.

I.	II.	III.	I.	II.	III.
1-4	7.65	7.32	101-110	11.35	10.73
5-10	8.47	8.52	111-120	11.05	11.12
11-20	9.50	9.34	121-130	10.95	11.00
21-30	10.09	9.74	131-140	11.26	11.17
31-40	10.96	10.31	141-150	11.66	11.71
41-50	10.68	10.27	151-160	12.42	12.17
51-60	10.93	10.52	161-170	11.83	11.44
61-70	11.02	10.84	171-180	11.67	11.13
71-80	11.21	10.72	181-190	11.59	11.26
81-90	11.38	10.64	191-200	11.31	11.30
91-100	11.58	11.15			

From this table it follows that the discoveries have, on the average, taken place in those parts of the orbits nearer the perihelion than the aphelion, and moreover that the later discovered planets are not specially fainter than those since No. 100.

*List of asteroids discovered in 1881.*

Number.	Name.	Date of discovery.	Discovered by—	Discoverer's number.
220	.....	Feb. 23, 1881...	Palisa .....	29

This is possibly 108 Hecuba.

**JUPITER.**—The annual report of the Chicago Astronomical Society, for 1880-'81, makes an interesting and valuable exhibit of Professor Hough's work for the year past. He has reached the conclusion which it would

seem natural for science to reach, namely, that drawings are only valuable when made by strict micrometrical measurements, and, indeed, that drawings on any other basis are misleading. He overlooks the fact however that a single *central* transit of the spot over a wire is several times more accurate than a micrometer measurement taken when the spot is not central. Jupiter presents such a variety of phenomena on his disk at different times that it has been the fashion to suppose that his surface is subject to sudden and rapid changes. The observations of the professor do not confirm this belief. "On the contrary," he says, "all minor changes in the markings or spots have been slow and gradual, such as might be produced by measurable mechanical forces. In fact, the principal features have been permanent, no material change being detected by micrometer measurement."

From 1,379 micrometer measurements on the great red spot, on the equatorial belt, the equatorial white spots, and the polar spots, a variety of interesting data are presented. Computed from observation of the red spot in 1879 the rotation period of Jupiter is  $9^h. 55^m. 34^s$ , or 8 seconds greater than the previously accepted value. In 1880 this value was  $9^h. 55^m. 35.2^s$ . Computed by the polar spots the rotation period is  $9^h. 55^m. 35.1^s$ . The computation from the equatorial white spots shows that these spots are in motion on the surface of the planet, the drift being about 270 miles per hour in the direction of the planet's rotation, or, in other words, that they made a complete revolution around the planet in about forty-two days.

Professor Hough regards the red spot as fixed. The equatorial belts he also seems to regard as fixed. The generally-accepted theory is that this planet is enveloped in a dense atmosphere; that the belts are a solid portion of the planet, and that the minor spots are clouds floating in the atmosphere. Professor Hough suggests an hypothesis, namely: that "the surface of the planet is covered with a liquid semi-incandescent mass; that the belts, the great red spot, and other markings are composed of matter at a lower temperature. The egg-shaped polar white spots are openings in the semi-fluid crust." This hypothesis, he thinks, would account for the slow and gradual changes, which do not seem reasonable on the simple atmospheric theory.

The great red spot on Jupiter's disk has for two or three years been attracting the attention of astronomers, and has been the subject of almost endless observations. Dr. Jedrzejewicz has published some inferences from his observations for ascertaining the time of rotation of the eastern extremity of the spot, made at his private observatory at Plonsk, during the winter of 1880-'81. The instrument employed is a refractor, six-inches aperture, with powers 225 to 300. In December he measured the length of the spot  $9''.8$ , and considers that his own observations, compared with those of Professor Schmidt at Athens, indicate that the length of the spot remained unchanged during the winter. On this assumption he finds for the time of rotation  $9^h. 55^m$ .



34.414<sup>a</sup>., by 174 rotations between November 25, 1880, and February 5, 1881. Professor Schmidt, from 1,021 rotations between July 23, 1879, and September 17, 1880, obtained the value 9<sup>a</sup>. 55<sup>m</sup>. 34.422<sup>a</sup>. for the middle of the spot. In 1862, by observations on a spot which he says was much darker, and with a more favorable object for the purpose than the spots observed by Airy and Madler in 1834-'35, and which was not much larger than the shadow of the third satellite, he had found for the time of rotation 9<sup>a</sup>. 55<sup>m</sup>. 25.684<sup>a</sup>.

From seven years' observation of the surface of Jupiter, Herr Bredichin concludes that the inequalities in the angular velocity of the different figures seen on the planet may possibly be explained by assuming (1) that in the neighborhood of the equator there is a solid, elevated zone, which, however, does not rise beyond the limits of the atmosphere, and (2) that the crust of the southern hemisphere transmits more internal heat into the atmosphere than that of the northern, and this affects the direction of currents of gases and vapors passing from one hemisphere to the other. The phenomena observed in that part of the crust which appears through the vaporous layer as a red spot prove, he says, the considerably deeper position of this spot as compared with the equatorial zone, and the preponderating heat development on the southern part of Jupiter. Herr Bredichin gives the distances of the southern and northern borders of the elevated equatorial zone from the equator, for the years 1874 to 1880, and he finds that the equatorial zone must be steeper to the south, while it has a more gentle fall to the north, so that here it is varying, and covered more or less with clouds and vapors. The highest strip of this zone seems to be 2" from the equator, on the north.

The French Academy of Sciences, on the 14th of March, again proposed the Damoiseau prize of 10,000 francs for a memoir deemed most competent "to review the theory of the satellites of Jupiter, to discuss the observations, and to deduce the constants which it contains, and particularly that which furnishes a direct determination of the velocity of light; and, lastly, to construct special tables for each satellite." Strange to say, in this age of keen astronomical research, this prize, when proposed in 1869, 1872, 1876, 1877, and 1879, met with no response.

SATURN.—Dr. W. Meyer, of Geneva, has employed the new Geneva (10-inch) equatorial in measures on the system of *Saturn*, which are to be continued. His first year's results show that the ball of *Saturn* is eccentrically situated as regards the boundary of the outer ring. He makes the diameter of the whole ring system 40".47; width of ring A (the outer ring), 3"; width of rings A and B together, on the west side, 7".18—on the east, 6".97; width of ring C (dusky ring), west side, 2".24—east side, 2".91; equatorial diameter, 17".42; polar diameter, 16".20; compression, 1÷14.5. These results are reduced to the distance 9.5389. While it seems to require further proof that the ring system is eccentrically situated with respect to the ball, there is a cer-

tain amount of evidence in its favor in past observations, as those of W. Struve and others. The writer has made a series of such observations for three years on the width of the dusky rings, and finds ring C wider on the east side than on the west side by about  $0''.3$ . Mr. Mayer's result is  $0''.5$ . Otto Struve found (1856)  $0''.2$ . While there is a strong probability that such minute differences as these result from real errors in the measures themselves, there is enough probability of a difference to make the measures worth a complete discussion.

## OBSERVATORIES.

The Imperial University of St. Petersburg has founded an observatory and placed it under the charge of Dr. Glasenapp. The equipment consists of two refractors, by Merz, of 6 and 4 inches aperture respectively, of portable and field instruments, and of an astronomical clock by Wirén. The director asks for an exchange of publications with other observatories.

A popular observatory has been established at the Palace of the Trocadero, Paris. Founded by M. Leon Jaubert, it has just been opened to the people, and many hundred free tickets have been applied for and received. Each ticket admits its owner to the observatory between 1 and 4 o'clock in the afternoon, and from 8.30 to 11 o'clock at night. It allows him to attend the practical school of astronomy, the demonstrations on instruments, the literary, the scientific conferences, and the popular laboratories of general physics.

A new observatory is being built by Columbia College, New York City. It is to be used in connection with the scientific department to instruct engineering students in the use of the portable instruments and equatorial. It is placed in charge of Prof. J. K. Rees, a graduate of the college. Proposals are being considered for building a 20-foot dome. According to the *Annuaire* of Brussels Observatory, for 1881, there are at present 118 public astronomical observatories in full activity, viz, 84 in Europe, 2 in Asia, 2 in Africa, 3 in Oceanica, and 27 in the two Americas. The United States alone have 19, Mexico has 2, Brazil, Chili, Columbia, Ecuador, the Argentine Republic, and New Britain 1 each. In Europe, Prussia is the state which has most public observatories; it has 29; next come England and Russia, which have, respectively, 14 and 12; then Italy, which has 9, Austria 8, France 6, Switzerland 4, Sweden 3, Holland, Norway, Spain, and Portugal, 2 each; lastly, Belgium, Greece, and Denmark. The oldest observatory in operation at present is that of Leyden, founded in 1632. In America, since 1870, six observatories of the best construction and most perfect equipment have been established.

An observatory is to be erected at Hong Kong, at a cost of about \$34,000, for the purpose of dropping a time-ball for the shipping and for carrying on magnetic and meteorological observations. From the official papers we notice that a decided impulse to this motion has been

given by the presence at Hong Kong of the United States surveying ship *Palos*, with Commanders Green and Davis, U. S. N., who are determining longitudes by telegraph throughout the China seas.

*The Etna Observatory.*—The building is partially completed, and surmounted by its revolving dome for the protection of the great Merz equatorial of 35 centimeters aperture. The observatory will not be ready to be opened until 1882. Great difficulties have to be surmounted in the building; all the materials have to be conveyed 3,000 meters above the level of the sea, and the season when work is possible is only three months out of the year. The mounting of the equatorial is finished, and the construction of the meteorological apparatus is going on.

Tabor College, in Southwestern Iowa, has just received a fine telescope, the joint gift of the Rev. Mark Hopkins, D. D., ex-president of Williams College, and the Rev. C. V. Spear, principal of Maplewood Seminary, Pittsfield, Mass.

Prof. C. A. Young has lately determined the position of the observatory of the scientific school of Princeton College. The longitude was determined by telegraphic exchange with Washington. It is  $9^{\text{m}} 34^{\text{s}}.538 \pm 0^{\text{s}}.021$  (7 nights). The latitude observations were in 5 series. The results were:

I.	$+ 40^{\circ} 20' 57''.791 \pm 0''.148$
II.	$57.763 \pm 0.116$
III.	$57.815 \pm 0.067$
IV.	$57.771 \pm 0.173$
V.	$57.775 \pm 0.088$

Series I is 82 observations on nine nights of 28 stars, with a transit by Kahler used as a zenith telescope. This telescope has a *broken* tube.

II is 59 observations of 49 pairs on two nights, with same instrument.

III is 114 observations of 49 pairs on three nights.

IV is 33 observations of 29 pairs on two nights, with a Fauth transit used as a zenith telescope.

V is a series of 37 prime vertical observations from 11 stars.

The final value of the latitude has a probable error of  $\pm 0''.044$ , something less than 4 feet on the surface of the earth. These numbers are worth quoting, as showing the accordant results which careful observers can obtain with small instruments.

#### INSTRUMENTS.

*A refractor of 27 inches.*—A short time ago the largest refractor in the world was successfully completed by Mr. Grubb, of Dublin, who has just had conferred upon him by the university of that city the honorary degree of master of engineering. This instrument has a steel tube  $3\frac{1}{2}$  feet in diameter at the center, tapering toward each end, of course. In length this tube is 33.5 feet, and the aperture is 27 inches. At first it was thought that the disks could be finished in a year by M. Feil, of

Paris, but it took him four years to produce perfect ones, and the difficulty he experienced was the main cause of the delay of the work. Although the entire moving parts weigh seven tons, through counterpoises and other expedients they can be operated at will by one man very easily. The circles are carefully and minutely divided, and the observer, while sitting in his chair, can read any of them by means of a little telescope attached to the side of the tube of the main telescope. A single gas lamp, hung by gimbals at the end of the declination axis, serves to light up each vernier and circle that may be required to be read. The castings of which the frame is formed are about ten tons in weight. The clock-work is controlled by Mr. Grubb's frictional governor and his new electric control apparatus. There are two right ascension circles, each 2 feet in diameter, one of which can be read from the eye end of the telescope and the other from the ground floor. The declination circle is 5 feet in diameter, and is read from the eye end of the telescope. This fine refractor is already placed in the magnificent observatory of Vienna.

Mr. Grubb has reprinted from *Engineering* his interesting papers on the manufacture of this telescope. We shall look with interest for an account of its actual performance.

The observatory of Williams College has mounted its new 5-inch Repsold meridian circle, and Professor Safford intends, we believe, to prosecute his zone observations which were unfortunately interrupted by his leaving Chicago.

This instrument is similar to those of Bonn, Brussels, and Strassburg in design, and is of the same size as those made or ordered for the observatories of Tokio, Wilhelmshafen, and Madison.

Mr. Burnham has lately invented a lamp for illuminating the webs of a filar micrometer through the end of the box, which is perfectly satisfactory in all respects. The first apparatus was made at the Washburn Observatory in Madison, and is described in its Publications No. I. The second was made by Alvan Clark & Sons for the new 12-inch telescope of the Lick Observatory. They are prepared to supply them to fit any micrometer.

The practical importance of this device is very great as it saves time and trouble, and by a steady and satisfactory illumination of the threads conduces to accurate bisections. Either oil or gas can be used in these lamps.

*A refractor of 30 inches.*—The flint glass for the 30-inch refractor for Russia has been finished by Alvan Clark & Sons within the year 1881, and we learn that the crown disk has been received from Feil and is found to be satisfactory so far as can now be known. Two attempts were made before the final successful casting. M. Feil will now proceed to the 36-inch disks for the Lick Observatory.

*The Washington refractor of 26 inches.*—An investigation of the objective and of two filar micrometers of the 26-inch Clark telescope of the Naval Observatory forms Appendix I of the Washington Observations

for 1877. The work was done by Professor Holden during 1876 and 1877. The exact dimensions of the objective were measured and the radii of curvature computed so that they are known within  $\frac{1}{16}$  of an inch. The indices of refraction could not be determined as the makers did not preserve any fragments of the glass. The focal length was measured and computed with assumed indices, and these agree to about 0.05 inch. The periodic and progressive errors of the screws were determined by means of a dividing engine and found to be practically zero. The two screws were made by the Messrs. Clark. The lengths of 1 revolution are—Screw I,  $0.018775 \pm 0.000002$  inch; screw II,  $0.018763 \pm 0.000001$  inch, at  $32^{\circ}$  F.

The values of these revolutions in arc have been determined in five different ways.

*A refractor of 36 inches for the Lick Observatory.*—The trustees of the Lick Observatory have finally closed the contract for the optical part of their great telescope. There has been considerable doubt whether a refractor or an enormous reflector would be selected, but the decision is in favor of the former. The object glass is to be 3 feet in diameter, and the Clarks of Cambridge, Mass., are to make it for \$50,000. The mounting for the instrument is not yet provided for. It will probably be about three years before the telescope is finished. If the instrument proves successful, it will be the most efficient ever pointed at the heavens. Its power will exceed that of the Pulkova glass by 44 per cent., and it will be almost twice as powerful as the great telescope at Washington, which at present is the best of its kind.—*San Francisco Scientific Press.*

A novel way of comparing clocks, distant from the standard clock, has been introduced at the Washburn Observatory, where it has been applied to a tower-clock, some 2,600 feet distant.

A single telegraph wire was led on poles from the observatory to the clock, with a ground connection at each end. In the circuit at the clock an ordinary microphone (Blake-transmitter) was put through a four-pointed switch at the observatory; the telephone can be thrown into the clock circuit, and a battery (usually of one or two standard Daniell's cells) is also brought into circuit.

When this is done the beats of the clock (every 2 seconds) can be distinctly heard. If the means of identifying the beginning of each minute are at hand, accurate comparisons between the tower-clock (error and rate unknown) and any of the observatory clocks can be made.

This has been accomplished in a very simple way as follows: On the wheel which moves the second hand (which revolves in one minute), a brass disk about 2 inches in diameter, which revolves with it, has been put. Near the outer edge of this disk is a steel pin. Six seconds before the beginning of each minute this pin picks up the short end of a lever, some 5 inches long, and raises the hammer end during 6 seconds. Exactly at 60 seconds the pin releases the hammer, which falls through

about one-half of an inch upon a small bell. This sound is distinctly heard through the telephone, and fixes the beginning of each minute. The minute is never doubtful, and consequently we have all the elements for rating this clock.

#### UNIFORM STANDARD TIME.

For some time past the American Meteorological Society has been engaged in the consideration of a uniform standard time, a matter of some moment from a popular and from a scientific standpoint.

A circular has lately been published by the society, which calls public attention to the great advantage of a more thorough uniformity of accurate time to the business community, as well as to the scientific world.

As at present arranged there is great uncertainty and confusion. Local time, in the astronomical meaning of the term, varies with every change of meridian. This cannot be conveniently retained by the traveling public or by railroad and telegraph companies. The result is that the most convenient meridian is adopted by each such transportation company.

Consequently over seventy such standard meridians are now in use by railroad and other companies throughout the United States and Canada. The larger towns and cities frequently adopt their own special local times, and the smaller ones adopt the railroad times most convenient to them. There are thus now in ordinary use at least one hundred local times or meridians, many of them differing but a few minutes from each other.

It is suggested, therefore, that the community at large unite upon a division of this continent into a few sections, and that throughout each such division all transportation and telegraph companies, all town clocks and clock-makers shall be kept in agreement with one standard meridian. Five such different standards would be established for the whole continent; a central meridian would be adopted in the Mississippi Valley, exactly ninety degrees or six hours west of Greenwich, and proceed to the east or west by steps of one hour each, as shown in the schedule given below. The meridian of five hours would be called "Atlantic time," that of six hours "Valley time," and the meridian of seven hours would be the standard "Mountain time" for the entire region of the Rocky Mountains, while "Pacific time," eight hours slower than that of Greenwich, would govern the time-keepers of the Pacific States.

*Proposed schedule of standard times.*

Geographical section.	Standard merid- ian west of Greenwich.	Standard time alower than Greenwich.	Standard time alower or faster than true "local time."	Designation of proposed standard time.
Newfoundland .....	0	A. M. S.	29 minutes slower than St. Johns, N. F.	Eastern time.
New Brunswick .....	60	4 0 0	24 minutes faster than St. Johns, N. B.	
Nova Scotia .....			14 minutes faster than Halifax, N. S.	
Canada .....			15 minutes slower than Quebec	
			18 minutes faster than Toronto	Atlantic time.
			16 minutes slower than Boston	
Maine to Florida .....	75	5 0 0	3 minutes slower than New York	
			8 minutes faster than Washington	
			19 minutes faster than Charleston	
			45 minutes faster than Montgomery	
Ohio to Alabama .....			14 minutes faster than Buffalo	Valley time.
Lower Lakes .....			30 minutes faster than Detroit	
			38 minutes faster than Cincinnati	
			0 minutes faster than New Orleans	
Mississippi Valley .....	90	6 0 0	1 minute faster than Saint Louis	Mountain time.
Missouri Valley .....			12 minutes faster than Saint Paul	
Upper Lakes .....			18 minutes faster than Kansas City	
Texas .....			19 minutes faster than Galveston	
			10 minutes slower than Chicago	Pacific time.
Rocky Mountain region ...	105	7 0 0	0 minutes faster than Denver	
			28 minutes faster than Salt Lake City	
			12 minutes slower than San Diego	
			10 minutes faster than San Francisco	
Pacific States .....	120	8 0 0	11 minutes faster than Olympia	
British Columbia .....			12 minutes faster than Victoria	

The evils spoken of undoubtedly exist, and eventually the number of local times in use on railroads and elsewhere must be reduced in the interest of every person who uses accurate time. This is not the place to discuss what changes would be best suited to meet the wants in the case, and the editor cannot here set forth in full his reasons for believing that this plan of the American Metrological Society will not be adopted by the people of the United States in general, who in the end will have what is most convenient to themselves. Nor can the grounds of selection of different standards of time (for in a country so large as the United States, there must be more than one standard time) be set forth here. It may suffice to quote the recent action of the State of Connecticut, which has adopted by law the time of the meridian of the City Hall in New York as its standard, and which obliges railways, etc., to conform to it. In the same way it seems to be wise for the Western States of Michigan, Wisconsin, and Illinois, to unite upon Chicago time as their standard, instead of taking the time of 6 hours from Greenwich. In this way every user of time will be supplied with the time he requires most often, and the growth of local standard times will be on a solid basis of use, and not a forced one of an artificial system.

The following note with regard to time-balls in the United States is of interest in connection with the subject of standard time.

The first time-ball established in the United States was dropped from the dome of the National Observatory at Washington, D. C., in 1855.

It is still dropped in Washington near noon, and has long furnished the standard time for the city and the departments of the Government.

In New York City a time-ball was established in 1877, dropped by an electric signal sent from the Naval Observatory at Washington. It was erected on the plans of Prof. E. S. Holden, and is maintained by the Western Union Telegraph Company, and is dropped from a staff on the tower of their building on Broadway.

At 11.55 the ball is hoisted half way up the staff on the tower. At 11.58 it is hoisted to its highest point, when it is about 250 feet above the street, and can be seen by the shipping at the New York and Brooklyn docks, and vessels in the bay, and from suitable positions is visible to a large portion of the citizens of New York, Brooklyn, Hoboken and Jersey City.

A time-ball at Boston, Mass., is dropped at noon of the latitude of that city by means of the noon signal from the standard clock of the Harvard College Observatory. It is placed in the large building of the Equitable Life Assurance Company, and was put up and maintained by that company at a cost of some \$1,200. The ball itself in this case is of copper and weighs 250 pounds.

A time-ball has lately been established from the plans of Dr. L. Waldo at Hartford, Conn., dropped by the Winchester Observatory of Yale College.

At St. Louis, Mo., another has been recently established.

At Kansas City another is dropped as a part of the time service of the Morrison Observatory under the direction of Professor Pritchett, at the expense of the city, and is highly commended. When raised the ball is lifted about 140 feet above the street, and is generally visible to the citizens of all parts of the city.

The ball itself is about three feet in diameter, made of a wire skeleton frame, covered with canvas, and painted black. To give it weight so as to drop with the needed celerity it is loaded inside with lead. It has a drop of about twenty-five feet and falls on a set of steel springs.

The manner of dropping these balls is extremely simple, and consists of withdrawing a steel pin by means of a magnet touched at the exact moment desired by the operator, whereupon the ball falls instantly.

#### ASTRONOMICAL BIBLIOGRAPHY.

The admirable *Catalogue générale* of Messrs. Houzeau and Lancaster is being issued in parts, and it is certain to prove of great use.

The second part of the *Catalogus Librorum* of the Pulkova Observatory has been received in America (printed in 1880). It is edited by Lindemann. This volume is on the same excellent plan as its predecessor, and its arrangement renders it priceless to the student of the history of astronomy. The growth of this unrivalled library may be exhibited by the following figures:

In 1845 there were 4,150 volumes, 60 maps, 3,109 dissertations.



In 1858 there were 7,625 volumes, 143 maps, 14,634 dissertations.

In 1880 there were 11,077 volumes, 168 maps, 23,208 dissertations.

A comparison of this collection with the bibliography of Lalande (using the resources of Paris) is given below. Column 1 shows the date of publication of the books; 2 shows the number of volumes at Pulkova not known to Lalande, and 3 shows the number of volumes mentioned by Lalande which are not at Pulkova:

	I.	II.
1472-1500.....	30	109
1501-1550.....	126	216
1551-1600.....	203	433
1601-1650.....	191	538
1651-1700.....	561	444

The *Astronomische Nachrichten*, the copyright of which is involved in the Schleswig-Holstein question, has been remodelled and will in future be published under the editorship of Dr. Krueger, the director of the observatory at Kiel, in co-operation with the president of the German Astronomical Society, of which association it will be a recognized organ. The new arrangement can produce nothing but good results, some of which are already evident.

A copy of the treatise of Copernicus, "De Hypothesibus Motuum Cœlestium," in a more perfect shape than any hitherto known, has been discovered at Stockholm Observatory, stitched into a copy of his "De Revolutionibus Orbium Cœlestium" which originally belonged to Helvius.

# METEOROLOGY AND ALLIED SUBJECTS.

BY CLEVELAND ABBE.

## INTRODUCTORY NOTE.

The compilation of this record for 1879-1881 having been undertaken at a late date, the time available for its preparation has been too short to allow of consulting the original scattered memoirs; it will therefore be found that the following pages consist almost exclusively of abstracts from those invaluable periodicals, the "*Zeitschrift für Meteorologie*," edited by Hann, at Vienna, and "*Nature*," edited by Lockyer, at London. It is hoped that but little of importance has been omitted, and that this record will bring to the notice of the American reader much that might otherwise have been overlooked.

## I.—INSTITUTIONS AND INDIVIDUALS.

Prof. H. W. Dove died on the 4th of April, 1879, at Berlin, and in him meteorology lost its most distinguished representative. Dove was born, October 6, 1803, at Liegnitz, and was made professor extraordinary at the University of Berlin in 1828 and became a member of the Academy of Sciences in 1845. Optics, electricity, and meteorology, but especially the latter, have alike profited by his activity. In 1846 the Prussian meteorological system was established through his efforts. He was not only an investigator, but a teacher of rare talent, and a lecturer who possessed in a high degree a talent of rivetting the attention of his audience. His public lectures at the university and his addresses before the Berlin Polytechnic Association were attended by hundreds of admirers. In whatever relates to the grand generalizations that may be deduced from meteorological observations, Dove has very properly been styled the "father of meteorology." (*Z. O. G. M.*,\* p. 193, XIV.)

Professor Dr. Johann von Lamont, director of the observatory at Munich, died on the 6th of August, 1879. He was born September 13, 1805, in the extreme north of Scotland. Removed to Regensburg, Germany, in 1817, and in 1827 to Munich. In 1828 he became assistant at the Royal Observatory at Bogenhausen, and, in 1833, on the death of Soldner, became the director. His numerous observations and investi-

\*The initials *Z. O. G. M.*, constantly used, designate the *Zeitschrift Oesterreichischen Gesellschaft für Meteorologie*.

gations in the field of astronomy, terrestrial magnetism, and meteorology have made him one of the most prominent scientists of Germany. In terrestrial magnetism his name stands beside Gauss. (*Z. O. G. M.*, XIV, p. 374.)

Karl Fritsch, vice-director of the Austrian K. K. Central Institute for Meteorology and Terrestrial Magnetism, died 1880, December 26, in his sixty-eighth year. He was essentially the founder of the Austrian Meteorological Association. From an excellent autobiographical sketch we quote the following items:

Born in Prague August 16, 1812, he states "that even in my youth I felt an irresistible tendency towards independence in all my conclusions. Neither the severity of my father nor the love of my mother was able to conquer my youthful willfulness."

His first definite impetus in the direction of the study of nature dated from the year 1827, as he began to interest himself in the meteorological observations made at the observatory of the University at Prague, and published daily in the "Prager Zeitung," and which were preserved by him. "From that time (November 18, 1827) was I body and soul a meteorologist." In the years 1831 and 1832 he began to make independent meteorological observations, and in part constructed the necessary instruments. Gradually every spare moment was given to this work and every other occupation "driven to the rear."

The contest between his love for astronomy, "the queen of all sciences," and meteorology, "the youngest of her sisters," was decided, as all the world knows, in favor of the latter.

In 1839 he became an assistant to K. Kreil in the new Magnetic and Meteorological Observatory at Prague, and the eleven years following, 1840 to 1850, show the extent and intensity of activity with which he devoted himself to that work. His first independent publication was presented at the end of the year of 1841 to the Bohemian Scientific Association, and bore the title "On the Simultaneity of Meteor Showers, especially the November Showers, with the Low Barometric Pressures."

The remaining forty years of his life afford a real illustration of successful devotion to the advancement of a favorite science, and in every application of meteorology to the practical affairs of life his skillful hand has been seen and the influence of his earnest life has been felt. After a tedious illness, on the 26th of December, 1879, he departed this life, "but for many years his memory will not be forgotten." (*Z. O. G. M.*, XV, 1880, p. 105-119.)

On the 29th of February, 1880, at Emden, Prof. Dr. M. A. F. Prestel died suddenly of heart disease. He was born at Göttingen in 1809, October 27, and his extensive series of observations and independent studies upon the climate of Emden have made his name everywhere familiar.

Ludwig Lose, one of the most industrious meteorological observers, died suddenly on November 6, 1880, in Créfeld. ▲ record of twenty-one

years of observation, nine times a day, testifies to his perseverance; during this time he and others have published numerous generalizations based upon these observations. He was born November 26, 1811, in Hanover. (*Z. O. G. M.*, Vol. XV, 1880, p. 100.)

Karl Weyprecht, born in Hesse-Darmstadt, 1838, died March 29, 1881. Having entered the Austrian navy, he, in the summer of 1872, undertook the conduct of the Austro-Hungarian Polar expedition, and since 1875 devoted himself to the establishment of the scientific and meteorological and magnetic investigation of the circum-polar regions which is now being executed by the International Polar Commission. His early death unfortunately prevented his realizing the success of the work he had so well planned and promoted.

Prof. E. H. Sainte Claire de Ville, born March 11, 1818, at Saint Thomas, in the West Indies, died July 1, 1881, at Paris. He filled the chair of Professor of Chemistry at the École Normale of Paris since 1851, and has, during this long interval, distinguished himself in all branches of chemistry. He held an important position in connection with the reorganization of French meteorology after the death of Le-verrier.

Prof. J. C. Maxwell, of Cambridge, England, born June 13, 1831, died November 5, 1879. Although known especially by his contributions to molecular physics, yet meteorologists have reason to remember his "Treatise on heat," and especially the last paper published by him on the "Theory of the wet-bulb thermometer."

Dr. C. C. Bruhns, born November 22, 1830, at Holstein, died July 25, 1881, at Leipzig, where he was the director of observatory of the university. Although devoted to astronomy, like several other astronomers, and perhaps especially through his interest in the subject of atmospheric refraction, he felt the necessity of a better understanding of the subject of meteorology, and accordingly Germany owes to him the organization of its first system of official uniform meteorological observations, namely, that of the state of Saxony, whose activity began in 1863. To him is also due the suggestion and calling of the international conference at Leipzig, 1872. The amiability and benevolence of his character endeared him to all with whom he had to do. (*Z. O. G. M.*, XVI, 1881, p. 489.)

The second International Congress of Meteorologists was held at Rome, April 14 to 22, 1879. All European States, including France and Greece, were therein represented; the United States representative, the late General A. J. Myer, unfortunately arrived too late. A permanent international committee was appointed who should continue in power until the next congress, which will probably meet in 1883 or 1884.

The Permanent International Committee of Meteorologists, established in accordance with the decision of the congress at Rome, held its first annual meeting on the 9th of May, 1880, at Berne, Switzerland. It will be the province of the committee by correspondence to execute

the various works authorized by the congress and to stimulate every movement that looks toward greater uniformity in instruments, reports, reductions, &c.

The International Polar Conference held its sittings in St. Petersburg August 1, 1881, and definitely settled upon a programme to be adopted in the international scheme for the exploration of the magnetic and meteorological phenomena of the Polar regions. The general schedule recommended at Berne was confirmed at St. Petersburg and the important details definitely agreed upon. Observations will begin in the autumn of 1882, and the following stations are assured: (1) Point Barrow, (2) Lady Franklin Bay, will be occupied by the United States. (3) A place on the west coast of Greenland will be occupied by Denmark, either Upernavik or Godthaab. (4) Jan Mayen, or the island of Grimsey near Iceland, to be occupied by Austria. (5) The stations of Bøsekop, near Alten, Norway, will be occupied by the Norwegian Government. (6) Mossel Bay, on Spitzbergen, will be occupied by the Swedish Government. (7) The mouth of the Lena and Nova Zembla will be occupied at one or more points by the Russian Government. (8) Canada will probably occupy Fort Simpson. France will occupy some island off Cape Horn, and Germany will occupy the island of South Georgia.

The observations will begin at all these stations at least as early as the first of August, 1882, and will be continued for at least one whole year. The stations occupied by the United States were, however, already occupied in the summer of 1881, and will continue for three years. It is hoped that most of the others will also be continued at least as long as this. The observations will refer principally to magnetism and meteorology, all other matters being considered secondary. The regular observations will be made hourly according to such system of time as may be desirable; but the magnetic observations that are made on term days, which days will always be the first and fifteenth of each month, shall be conducted according to Göttingen time.

The meteorological observations are to be conducted as nearly as possible on a uniform system and with instruments of uniform accuracy, the minutest details for which are given in the regulations of the conference.

The magnetic work will consist of both absolute and differential observations. The absolute measures will give the declination and inclination within one minute of arc, and are to be accompanied by special magnetic study of the neighborhood, for the purpose of detecting local irregularities.

The differential observations will also refer to all three elements of terrestrial magnetism, and it is desirable that each station should have two complete sets of instruments. The variation instruments will be furnished with the smallest possible needles. Observations will be made hourly, except on term days, when they will be made every five minutes; on such term days, moreover, during one hour complete observations will be made every twenty seconds.

Especial attention will be given to observations of the aurora, which will be recorded hourly. The astronomical observations will be confined entirely to the determination of the latitude and longitude and local time.

Among the subjects suggested by the commission are hydrographic investigations, the altitude of auroras, atmospheric electricity, the twilight, the collection of samples of air for chemical analysis.

The observations will all be reduced and published on a uniform plan. All observatories throughout the world, especially those where magnetic observations are made, are earnestly invited to continue their work during the next two years, and the electricians of telegraph companies are urged to consider the great importance of accurately observing the earth currents on telegraph lines.

The methods of computation and reduction of the meteorological observations will be adopted in conformity with the meteorological congresses held at Vienna and Rome. Summaries of the observations will be sent as soon as possible after the return of each expedition to the President of the International Polar Commission, through whom they will be rapidly published. The collected observations will also be published in full after they have been properly reduced, to which purpose the Polar Commission will, after the return of the expeditions, meet together for a further consideration of the subject. In this publication the metric system and centigrade temperature will be adopted. The commission recommends the publication of an occasional report or journal of proceedings.

The present membership of the Polar Commission is as follows: For Denmark, Captain Hoffmeyer; for Russia, Professors Lenz and Wild, and Lieutenant Jürgens; for France, Professor Mascart; for Norway, Professor Mohn; for Holland, Dr. Snellen; for Sweden, Dr. Wykander; for Austria, Count Wilczek and Lieutenant Wohlgemuth; for the United States, General Hazen and Professor Hilgard; for Canada, Prof. Charles Carpmæl; for Germany, Dr. Neumayer; for England, Mr. R. H. Scott; for Finland, Professors Nordenskiöld and Lemström.

The first annual volume of the observations of the meteorological observations in Bavaria, under the conduct of Bezold and Lang, was published in 1880. It gives convenient tables for the reduction of observations to sea-level, and a study of the thunder storms in Bavaria, during 1879. Owing to the great number of thunder-storm observers it has become possible to demonstrate a feature that has frequently been suspected elsewhere, viz, that such storms occasionally break out simultaneously over a long expanse of country. The details of observation for forty-nine years at Beyrout are also published. (*Z. O. G. M.*, vol. XV, 1880, p. 334.)

The Meteorological Commission of the Natural History Society of Switzerland, which is represented by R. Wolf and R. Billwiller, announces that if possible a meteorological station will be maintained at

the summit of Santas-Gipfel, at an altitude of about 10,000 feet. (*Z. O. G. M.*, Vol. XV, 1880, p. 329.)

The central committee of the Germano-Austrian Alpine Association, animated by the desire to further the study of Alpine meteorology, has established a self-registering aneroid barometer, as constructed by Goldschmidt (to whom Hottinger now succeeds), upon the summit of Schaffberg. This establishment was personally attended to by Kostlivy; and the observations are supervised by Grömmner, the proprietor of the Schaffberg hotel. The publication of the first two months' hourly records at this point has given Hann occasion to collect together what little is known upon the whole subject of barometric pressure at high stations. The need of further observations in Europe and America is strongly urged by him. He says there can be no doubt that the modifications that we see entering into the diurnal variation of pressure, as we ascend higher, and higher on isolated mountain peaks, is produced, in the first place, by the diurnal change of the mean temperature of the column of air between the top of the mountain and the base; and, in the second place, also, by the change from ascending day-winds to descending night-winds, such as we observe everywhere in mountain regions. Both these causes have a tendency to raise the pressure at high stations up to the moment of the maximum temperature, and to lower it at the time of minimum temperature. Herein lies the reason for the lateness of the morning maximum, the enfeebling of the afternoon minimum, and the development of the morning minimum until it has become the principal minimum of the day. But the magnitude of this influence is, at least in our latitude, as variable as is the temperature of the air and the prevailing wind. A formula for the diminution of daily range with the altitude is therefore a somewhat fruitless labor. (*Z. O. G. M.*, XIV, p. 177.)

The organization of a special meteorological service for the Kingdom of Bavaria has been accomplished by the establishment of a central station, fifteen or more second-class, and nineteen or more third-class stations, all of which are under the general supervision of Prof. W. Von Bezold. The observers are generally the professors of mathematics and sciences at the schools and universities of the kingdom. A general commission of members of the Royal Academy of Sciences acts as the adviser of the Bavarian Government in these matters. (*Z. O. G. M.*, XIV, p. 173.)

The first conference of the International Meteorological Committee, as appointed at Rome, was held at Berne in August, 1880; the following is an abstract of the results: It was recommended that a careful comparison be made between the normal instruments of each land and those to be used by other neighboring nations. The moment of international simultaneous observations was changed in accordance with the request of the chief signal officer. The international polar observations were emphatically approved of. C. Köppen's proposed improvement in

the method of recording rainfall was agreed upon, and will be submitted to the national weather bureaus. The committee expressed the hope that telegraphic connection with the islands of the Atlantic Ocean would soon become practicable on account of its great importance for the weather service in Europe.

Captain Hoffmeyer's proposal that all central meteorological institutes should regularly publish the mean values of the more important climatic elements was urged upon the general attention. Dr. Hellman's proposition to compile a catalogue of works on meteorology was referred to a committee, with power to act in case others would co-operate.

The subject of international tables for the reduction of observations was referred to Messrs. Mascart and Wild to prepare a plan for the computation and arrangement of the tables. (*Z. O. G. M.*, Vol. XV, 1880, p. 398.)

According to the conclusion of the First Italian Meteorological Congress at Turin, September, 1880, the earlier Alp and Appenine meteorological correspondence and the Italian Meteorological Association unite together in a new general association under the presidency of the King of Italy, and the meteorological journal carried on by Ragona at Modena is now merged with that of the Italian Association. (*Z. O. G. M.*, Vol. XVI, 1881, p. 90.)

The first two volumes of the Archives of the Deutsche Seewarte have been published in the years 1880, 1881, respectively, and give for the first time a connected view of the extensive field covered by the energetic operations of that institution, which in the number of its stations ranks next to the United States Signal Office, in its scientific work vies with the Central Physical Observatory at St. Petersburg, and in its marine work surpasses the meteorological office at London. Beside the complete description of the Seewarte and details as to the work carried on in the separate divisions, these volumes also contain valuable memoirs by Sprung, Köppen, Rumker, etc.

Attention is paid equally to observations and predictions of the weather on land, observations and generalizations relative to ocean meteorology, physical, and mathematical studies, terrestrial magnetism, the investigation of the errors of sextants, chronometers, and other instruments used by navigators, and bibliography of meteorology. The assistants in charge of the separate divisions, namely, Messrs. Koppen, Sprung, Van Bebber, and Rumker, are already well known by the original works they have published. (*Z. O. G. M.*, XVI, 1881, p. 111.)

In Italy considerable progress has been made toward unification of interests on the one hand by the concentration of government work in one bureau, having its headquarters at the Observatory of the Collegio Romano, under Prof. P. Tacchini, and on the other hand by the union of the independent individual organizations into one Italian Meteorological Association, having its secretary and business center in Turin



(13 Via La Grange), but its scientific president (Prof. P. F. Denza) at the Carl Albert Observatory, Moncalieri.

The publications of the previous government bureau and of the earlier association have also been combined in some respects, and those of the central office now appear in magnificent royal folios, of which the first volume is that for 1879. (*Annali dell' ufficio centrale di Meteorologia Italiana*, Serie II, Vol. I, 1879, Roma, 1880.) The office has 69 first-class stations, and maintains a daily bulletin of telegraphic reports, and a ten-day summary of data of interest to agriculture. The annals contain numerous memoirs by Chistoni, Cantoni, Tacchini, &c., the detailed observations at 49 stations, and the astronomical work done at the Observatory Collegio Romano by Tacchini and Millesovich.

In France the Bureau Centrale de Météorologie has assumed the publication of observations made at all the French stations; a similar step was taken in the United States when the Army Signal Office, in 1874, assumed charge of the voluntary as well as the enlisted observers. Therefore the annuaire of the Meteorological Society of France, beginning with its twenty-eighth year, 1880, appears in a somewhat modified form, containing only monthly summaries of its eleven stations, and devoting much more space to original memoirs and to reviews of other publications relating to meteorology.

At the suggestion of H. O. Russell, an Intercolonial Meteorological Conference was held at the Sydney Observatory, N. S. W., November 11 to 14, 1879, to consider propositions for improving the system of weather signals, and securing more united action in regard to weather telegrams. At this conference numerous propositions, seventy-four in all, were adopted relative to all the colonies of Australasia, as well as to the subject of different stations, uniform methods, apparatus, and times, mountain stations, priority of weather reports, telegraph cipher codes, &c.

The second Inter-colonial Congress was held at the Melbourne Observatory April 21 to 27, 1881. The various colonial government meteorologists reported upon the many points in which progress had been made during the previous eighteen months. Dr. Hector stated that in New Zealand, in 1867, he had urged the importance of this work, and that the unscientific work of the weather-forecasting department, which had been carried on since 1874 by Captain Edwin, had now, since June, 1881, been superseded by the weather charts and daily predictions for each of five districts by the government meteorologists. His outlying stations had been extended to the Feejee Islands and to Chatham. Messrs. Russell, of Sydney, and Todd, of Adelaide, and Ellery, of Melbourne, reported upon improvements in the daily maps and bulletins, on new high stations, and other improvements. The discussion then turned on methods of exposing thermometers, the measure of evaporation, the reliability of anemometers, (Ellery has established one of Hagemann's vacuum anemometers, and Russell has used a portable

hand form of Robinson's anemometers) black bulb or radiation thermometers. The adoption of isobaric curves was agreed on, as also the standard base maps on Mercator's projection, as also a system by means of which to effect the reduction of all the instruments to uniform systems of standards. It is thus seen that the southern hemisphere, by means of the extensive system of weather observations in Cape Colony, Australasia, Argentine Confederation, and Chili, is, relatively speaking, as well provided for on the land as the northern hemisphere was a few years ago; and the principal extension now needed is the securing of observations from the smaller islands and the increase of observations on ships.

The Central Meteorological Institute in Zurich, that has for years been supported by the general Swiss association of scientists, was, by decree of December, 1880, constituted a permanent official national institute, and will bear the title "Central Swiss Meteorological Institution." It is intrusted with all official meteorological work, including observations, investigations, predictions, &c., and is governed by a commission organized under the department of the interior, and of which the principal members are Profs. R. Wolf, of Zurich; E. Plantamour, of Geneva; S. A. Forel, of Morges; E. Forster, of Berne; E. Hagenbach, of Basel; H. Weber, of Zurich; and Coaz, chief forester at Berne. Prof. R. Billweller is confirmed as director of the institute. (*Z. O. G. M.*, XVI, 1881, p. 248.)

The death of Brig. Gen. Albert J. Myer, which occurred at Buffalo on August 24, 1880, and the subsequent appointment of Maj. Gen. William B. Hazen as Chief Signal Officer, has been a most important event in the history of meteorology in the United States. The Signal Corps of the Army owes its inception and establishment to General Myer, and since the meteorological duties were imposed upon it, in 1870, "has had its growth in the generous support of the American people, and year by year an increased confidence has been shown in the usefulness of its work." The spirit that has been infused into the service by the accession of General Hazen is shown by the following quotation from his first annual report: "The weather service of the United States has been without a rival in the practical advantages derived from its labors, but the day has now come when it should take its stand among the foremost in the scientific study and investigation of the higher branches of theoretical meteorology, and it is upon such investigations intelligently pursued that the hoped-for greater benefits must mainly rest. I have endeavored to bring this service into active sympathy and co-operation with the ablest scientific intellects of the country."

Among the numerous novelties briefly enumerated by General Hazen in his report for the year ending June 30, 1881, are: raising the standard of the *personnel* of the corps; the weather forecasts for several days; the organization of special service for the benefit of the cotton interests and the fruit interests; the preparation of new instructions, tables, instru-

ments, &c.; the executing of studies in atmospheric absorption by Langley on Mount Whitney; the offering of prizes for essays on meteorology; the establishment of stations for investigating meteorology in Arctic America, &c.

The attempt to render weather maps and meteorological observations useful to the agricultural community has been fairly made in Saxony by the erection of the special meteorological station in Magdeburg. This is a massive tower 34 meters high, at the intersection of two streets. In the basement is a room where the temperature changes are slight, and here are kept the normal barometer, the barograph, &c. The thermometer and anemometers are on the topmost story, and the working rooms of the corps on the intermediate floors. Near by, on an appropriate grass lawn, are the standard thermometers for air and earth temperature, and the evaporimeter, rain-gauge, &c. All of this is the property of the Magdeburg Zeitung, and is in charge of Dr. Assmann.

The daily bulletins and predictions are made up at noon, and an edition of 500 copies sent out at 1 p. m. These are also republished in the evening edition of the Zeitung. Numerous special reports for local stations are made up at 12.30 p. m., and also a telegraph bulletin of predictions that is distributed gratuitously and daily by the Magdeburg railroad to all its stations, and a bulletin for public use. (*Z. O. G. M.*, XVI, 1881, p. 381.)

In Italy, much interest is expressed in the establishment of physical and astronomical observatories at high altitudes. Tacchini has interested himself in the establishment of a very complete observatory at Casa Degli Inglesi on Mount Etna. At the close of 1881 the building had been completed, but the apparatus and observers not yet secured. A less extensive observatory is in the course of construction on Monte Cimone (altitude 2,233<sup>m</sup>), and the erection of one on Gran Sasso d'Italia is contemplated. (*Z. O. G. M.*, XVI, 1881, 469.)

The Annual Report of the London Meteorological Council for the year ending March, 1880, shows the number of reporting stations to be as follows: Class I, 9; II, 5; III, 37; IV, 22.

The number of verifications of daily predictions is stated as follows:

	Verified.	Failed.
Storm warnings.....	50	21
General weather predictions .....	28	5
Special hay-harvest predictions.....	48	9

Among the special investigations and reports now on hand are the following: (a) A third volume of the Meteorology of Arctic Regions; (b) Observations at Kew on the influence of altitude on the thermometer; (c) The observations of Cambell's sunshine recorder; (d) Studies and comparisons of various hygrometers; (e) Photography of clouds; (f) Observations in balloons; (g) The sluggishness of the marine barometer; (h) The application of Thompson's harmonic analysis to the computation of periodical series. (*Z. O. G. M.*, XVI, 1881, p. 493.)

T. C. Mendenhall (now of Columbus, Ohio) has prepared a memoir upon the meteorology of Tokio for the year 1877, which has been published by the University of Tokio. It would seem meteorological observations are also made and published by the Sapporo Agricultural College under the supervision of William Wheeler, professor of mathematics, and also made at the Imperial College of Engineering, where they have been in charge of Professors Ayrton, Perry, and Dyer, successively. Besides all these the Japanese meteorological office publishes an official series. The admirable work of Professor Mendenhall will probably be continued by his successor, Prof. H. M. Paul (formerly of the Naval Observatory, Washington), and it is hoped may serve as a model for the numerous other meteorologists and observers of Japan.

It seems specially desirable that some observing stations should be established in the northern portion of the Japanese Empire. (Later information is at hand to the effect that a Japanese storm signal office has been established by the government in charge of the well-known German observer, Dr. E. Knipping.)

## II.—GENERAL TREATISES, BIBLIOGRAPHY, ETC.

A second edition of *Mohn, Grundzüge der Meteorologie*, was published in Berlin, 1879. Besides numerous improvements in the charts and tables, this work is especially distinguished by the incorporation therein of the recent progress in dynamical meteorology.

Dr. A. Ritter has published (Hanover, 1879) a work embracing the results of studies hitherto published in Poggendorff's *Annalen*, and dealing with many problems relative to the atmosphere of the earth, the sun, and other planets. The full title is, *Anwendungen der mechanischen Wärmetheorie auf kosmologische Probleme. Sechs Abhandlungen über die Constitution gasförmiger Weltkörper*, Hanover, 1879. (*Z. O. G. M.*, XV, 1880, p. 150.)

The subject of a bibliography for meteorology was reported on in the congress at Rome by Dr. G. Hellmann, who interests himself exceedingly in this subject, and who certainly expresses the views of all in saying that the necessity for such a work is felt on all sides, and that its publication would truly be an important step in the progress of science. Some preparation had already been made towards realizing this idea, especially by Reuss, Poggendorff, Struve and others. The propositions made by Hellmann to the Meteorological Congress were commended to the favorable action of the international committee, whose action, however, has been delayed by the want of funds. General Hazen has secured for the United States Army Signal Office the extensive card-catalogues compiled by Symons, of London, and Abbe, in Washington, and proposes soon to publish these as a small but welcome contribution toward the exhaustive bibliography which is so much desired. Meanwhile the

second volume of the catalogue of the observatory at Poulkova, and the admirable bibliography of astronomy by Lancaster, have been published, and contain much meteorology. A third volume of Poggendorff's great work and a catalogue of Dove's library are also in course of preparation. (*Z. O. G. M.*, XIV, 1879, p. 97.)

Rubenson has published a Swedish "handbook of nautical meteorology," which contains also data and considerations that are novel and of interest to meteorologists, although the work is generally intended for use in the Swedish navy and merchant marine. (*Z. O. G. M.*, XVI, 1881, p. 455.)

J. C. Houzeau and A. Lancaster have published a general treatise on meteorology (324 pages octavo) that fairly represents the elements of this science so far as they can be understood without the help of mathematical symbols. The special chapter on weather charts and weather and storm predictions and the utilization of meteorological observations will attract attention.

Among the new periodicals devoted to meteorology, we note "Ciel et Terre," published bimonthly, beginning March, 1880, under the editorial direction of an active corps at Brussels, among whom we notice Lancaster, Houzeau, Hooreman, von Rysselberghe.

Blanford's annual report on the meteorology of India for 1878 and 1879 (Calcutta, 1880 and 1881, respectively) has been received. The temperature tables are given for about 125 stations, the rainfall for about 400. The Madras Presidency continues to sustain an independent meteorological office, while the other provinces have come into union with the central office at Calcutta, an arrangement that promises many advantages so long as the latter is under the present able management.

The Royal Meteorological Institute of Prussia, under the direction of Dr. G. Hellmann as successor of Dove, has published in the "Ergebnisse" for 1880 the result of observations at 130 stations. Special details are given for the high stations, viz: Schneekoppe 1,599<sup>m</sup>, Brocken 1,142<sup>m</sup>, and the corresponding base stations at altitudes 348<sup>m</sup> and 222<sup>m</sup>, respectively. The summaries for each station are given in the form recommended by the International Congress of Meteorologists. (*Z. O. G. M.*, XVI, 1881, p. 528.)

The Central Meteorological Bureau of France has published its *Annales* for 1878 and 1879 in magnificent quarto volumes, four of which, it would seem, are expected to appear each year. For 1878 we have as follows:

I.—Study of thunder storms in France by Fron, followed by Ed. Becquerel's observations of earth temperatures, Angot's tables of reduction to sea-level, and some minor memoirs by Hildebrandsen and Rollin.

Vol. II contains the daily observations at French and Algerian stations; these are arranged on a scheme adopted by the International Meteorological Commission. This is followed by a valuable review by Angot, month by month, of the climatology of 1878.

III.—This volume is entirely devoted to the rainfall in France, and gives the results of daily observations of 1,069 stations in France, together with summaries by seasons and the year.

IV.—This volume contains two memoirs on general meteorology by Leon Teisserence de Bort, on the distribution of temperature and pressure during January and July.

For 1879 we have as follows: I.—Studies upon the thunder storms of France for 1878 by Fron, in continuation of the series of memoirs on this subject which he has published annually for many years past. This is followed by shorter memoirs by Edward and Henry Becquerel and Raulan (results of rainfall observations at 200 stations in France). The method of reducing barometric observations to sea-level used at the French stations is explained with tables by A. Angot, to whom it is due. Angot assumes the temperature of the bottom of the air column to be that of the observed or upper station, plus one degree Centigrade for each 180 meters of altitude. The volume concludes with a biographical notice of Le Verrier.

The Annals for 1879, Part IV, "Météorologie Générale," contains (1) M. de Tasse's general theory of atmospheric circulation; (2) Teisserence de Bort's study upon the atmospheric circulation on the continents. (*Z. O. G. M.*, XVI, p. 485-488.)

The Annuaire of the Meteorological Society of France, Vol. XXVIII, for 1880, contains among memoirs the following of general interest: C. Ritter, Provisional Theory of Aqueous Meteors, accompanied by excellent representations of various forms of clouds; Renou, Compensation of Aneroid Barometers; Angot, New Tables for Barometric Hypsometry; Louvet and Carré, Rainfall in the Department of l'Orient. (*Z. O. G. M.*, XVI, p. 494 and 526.)

The London Meteorological Office has published part 2, Contribution to the Meteorology of the Arctic Regions. This volume contains the original journal of observations of ten vessels that have visited the region in Arctic North America between 45° and 120° west longitude and 60° to 80° north latitude. These are in detail as follows: Sir John Ross, October, 1829, to May, 1832; Sir G. Back, August, 1836, to July, 1837; Sir T. Austin, September, 1850, to August, 1851; Capt. W. Penny, September, 1850, to August, 1851; Sir Edward Belcher, September, 1852, to August, 1854; Sir F. C. McClintock, 1857, to July, 1859. Special attention has been given by Strachan to the careful investigation into accuracy of thermometers, and the working up of the records of temperature, pressure, and wind. (*Z. O. G. M.*, XVI, 1881, p. 483.)

Hirth has collected all that is known relative to the etymology and history of the word "typhoon." Among his references is given a translation from the Chinese annals of the island of Formosa, which was first published in 1694. According to this work "typhoon" is equivalent to "t'ai-fung"; "fung" is old Chinese for wind; "t'ai" is a word from the language of the earlier inhabitants of Formosa.

The old chronicle says "the winds that blow on the Sea of Formosa are very different from those of other seas. A very strong wind is called 'ku'; such a wind of greater violence is called t'ai. The 'ku' rises and falls suddenly, while the t'ai blows continually day and night. Storms that blow from February to May are 'ku'; those that blow from June to September are called 't'ai.' In October the north wind begins.

"When one speaks of a wind that blows from every direction of the compass it is called 't'ai.' We know no 't'ai,' no matter how severe, that does not follow the rule of blowing from all directions. If, for example, it blows from the north, then from the north it will turn to the east, and from east to south, and from south to west." (*Z. O. G. M.*, XVI, 1881, p. 431.)

Hildebrandsson has published a summary of the observations made on the coast of Siberia by Nordenskiöld during the Vega expedition from North Cape to Yokohama. The following table gives some of his results:

Months.	Temperature.	Pressure.	Prevailing winds.	Cloudiness.
	<i>° C.</i>	<i>mm.</i>		
January .....	-25.06	752.79	North.	6.0
February .....	-25.09	767.99	N. N.W.	5.6
March .....	-21.65	759.28	N.	5.1
April .....	-18.93	754.72	N. N.W.	6.4
May .....	-6.79	759.74	N. N.W.	8.5
June .....	-0.60	756.37	N. N.W.	7.0
July .....	+ 2.68		S. S.W.	7.5
August .....				
September .....				
October .....	- 5.20	757.83	N. N.W.	8.6
November .....	-16.58	753.81	N. N.W.	8.4
December .....	-22.80	760.87	N.	7.0

As opposed to the prevailing NW. wind the observations of clouds show that a steady SE. current prevailed overhead. (*Z. O. G. M.*, XV, pp. 369-378.)

### III.—METHODS, APPARATUS, &c.

Sohncke has made an investigation into the gradual change in the correction for instrumental error of barometers, especially those of the meteorological stations in the principality of Baden. These station barometers are all mercurial-cistern barometers, manufactured by Hermann & Pfister, and were all originally compared with the central barometer at Carlsruhe by means of a portable barometer made by Fortin. In 1874, a new tube, apparently in perfect condition, was introduced into the barometer at Carlsruhe, on account of an accident to the original tube, which had preserved its condition satisfactorily during the preceding six years.

The new barometer tube, in the course of the first three years after its introduction, experienced a large change, as is shown by two entirely independent methods: namely, first, by the direct comparison with the portable barometer, and second, by its comparison with all the station

barometers in Baden. The following table gives the difference (Carlsruhe minus portable) as the result of comparisons with the portable barometer:

Date.	Difference.	Date.	Difference.
	<i>mm.</i>		<i>mm.</i>
March, 1874 .....	+0.54	March, 1876 .....	-0.00
April, 1874 .....	+0.50	May, 1876 .....	-0.13
August, 1874 .....	+0.40	August, 1876 .....	-0.30
April, 1875 .....	+0.00	March, 1877 .....	-0.20
May, 1875 .....	-0.04	May, 1877 .....	-0.10
August, 1875 .....	-0.10	July, 1877 .....	-0.20

It follows from the above figures that the difference between the two barometers had in the course of three years changed by  $0.74^{\text{mm}}$ , and several considerations go to show that this change has been of the nature of a gradual sinking of the mercury within the new tube of the Carlsruhe. During the years 1870 to 1876, a number of inspecting tours had afforded an opportunity of comparing the Carlsruhe barometer with the barometers at the other stations. These comparisons show that the Carlsruhe barometer changed but little in respect to the others until 1874, after which date there was a general change in the same direction in their relative standings, the amount of which agrees closely with that previously determined. Sohncke very properly concludes that minute quantities of air and vapor must have escaped upwards into the vacuum chamber of the Carlsruhe barometer, and as this instrument is apparently not in any way inferior to the standards generally used in Europe, it was reasonable to conclude that similar defects occur in other barometers. (*Z. O. G. M.*, 1879, Vol. XIV, p. 141.)

Schreiber has elaborated the ideas contained in the so-called balance barometer, and has constructed a self-registering apparatus for both pressure and temperature, which, after many months' testing, has been purchased for the use of the German Seewarte, at Hamburg. The instrument consists of three parts: 1. The barometer on whose theory and corrections the elaborate investigations by Schreiber, in 1876, are already well known. 2. The thermometer for the temperature of the instrument, which is constructed like the barometer. 3. The thermometer for the temperature of the air, which consists of a copper vessel, holding 5 liters, which is placed outside the apparatus, and is connected with the self-registering portion by means of a small lead tube, which latter enters into a balance manometer within the case with the barometer. The movements of the manometer are recorded in a manner precisely simultaneous with the other two instruments. (*Z. O. G. M.*, Vol. XIV, 1879, p. 486.)

Schreiber has also devised methods by which the balance manometer can be applied to the registration of a variety of phenomena; and even to the integration of the registered curves. (*Z. O. G. M.*, Vol. XIV, 1879, p. 487.)



Hellmann having stated that in his opinion "the attempt recently made to establish an international meteorology must be regarded as a failure, since the prime and most elementary condition of uniformity as regards hours of observation has been neglected," Hann very justly replies that the only object one can imagine likely to be attained by uniformity in the hours of observation on local time is either directly comparable mean values for the various meteorological elements, or else a convenience in tracing the differences in the diurnal changes of these elements for various localities. But the study of actual observations will speedily convince one that three daily observations will not give the necessary data for comparing the peculiarities of climate in various latitudes and altitudes, and continents and coasts. According as we lay greater stress upon the pressure, the temperature, clouds, moisture, winds, &c., we must choose different hours of observation. And it is therefore necessary that in every land hourly observations should be made, if we hope to attain the objects that Hellmann seems to have in view. We are of the opinion that the present system of international observations in Europe is a very useful one, and marks a great progress in comparison with the condition of things before the Vienna Congress of 1873. One can imagine better things still, but we "must not allow the better to be the enemy of the good." (*Z. O. G. M.*, Vol. XIV, p. 263.)

Dr. Galle, director of the observatory at Breslau, in deducing the annual temperature curve for that observatory, from daily means based on eighty-five years of observation, has adopted the following method, which is shorter and more rational than that of Bloxam. If for a series of consecutive days . . .  $n-2$ ,  $n-1$ ,  $n$ ,  $n+1$ , and  $n+2$ , we have the mean observed temperatures  $t_{n-2}$ ,  $t_{n-1}$ ,  $t_n$ , &c., and we desire more accurate determination of the temperature  $t_n$  of the middle one of these days; then it is plain that if the mean daily temperatures are uniformly increasing or decreasing, the true temperature  $t_n$  will be given by the formula:

$$\frac{1}{2}(t_{n-1} + t_{n+1}) = M_1; \quad \frac{1}{2}(t_{n-2} + t_{n+2}) = M_2, \text{ \&c.}$$

and a value  $t_n$  comparatively free from small errors of observation by taking the mean of five such values. But if the observed daily mean temperatures should not have uniform weights in forming the desired mean, because the temperature during these days has not changed uniformly, then the observations must be combined according to the methods defined by the law of probabilities, and this method is particularly convenient of application when we attempt to combine together seven consecutive daily means. Thus if for brevity  $a = t_{n-3}$ ,  $b = t_{n-2}$ ,  $g = t_{n+3}$ , we then have either one of the following formulæ:

$$1. \quad t_n = \frac{1}{10}(3c + 4d + 3e)$$

$$2. \quad t_n = \frac{1}{12}(b + 3c + 4d + 3e + f)$$

$$3. \quad t_n = \frac{1}{16}(a + 4b + 9c + 12d + 9e + 4f + g)$$

The computation, however, may be more simply arranged if for each day we make the combination :

$$4. \frac{1}{10}(b + 2c + 4d + 2e + f)$$

and call the new means thus found for each successive day  $a_1, b_1, c_1$ , &c. We have then to combine these new means according to the following formula :

$$5. t_n = \frac{1}{2}(c_1 + 2d_1 + e_1)$$

The  $t_n$  thus computed will be the same as given by equation No. 3, and the whole process is reduced to a simple system of summing and halving. (*Z. O. G. M.*, XIV., p. 380.)

Pernet, who is now in charge of the International Bureau of Weights and Measures, at Sevres, in a memoir on the determination of the fiducial points of the mercurial normal thermometers, and the determination of temperatures to the hundredth of a degree centigrade, says: Carefully calibrated thermometers, handled in various manners, do not agree with each other even in the interval between freezing and boiling point of water. The differences, under some circumstances, amount to several tenths of a degree, and are therefore much greater than the errors of observation. They depend in part upon the irregular expansion of glass, but still more upon the fact that the bulb of the thermometer after being warmed does not immediately return to its original volume, although it may do so in the course of time, and in consequence of this a temporary lowering of the freezing point is produced. Since this depression of the freezing point appears thus far to be subject to no law, we are prevented from attempting to make different thermometers agree among themselves.

This is very much to be lamented, for if it were possible for us to deduce from the observations of various thermometers according to a general method of computation temperatures agreeing with each other, then would every doubt as to the correctness of the measurements of temperatures be removed. He gives the following methods for determining the fiducial points and for the computations of the corrections depending thereon.

First. Determination of the freezing point: Fresh fallen snow is the best material; the snow must be thawing throughout its whole mass, must be clean and pure. The next best substitute is fine shavings of natural ice; artificial can only rarely be used. The thermometer and scale must be covered up to above the freezing point with snow or ice. The determination must take place in a cool room, and the ice must not press upon the thin glass of the bulb, else otherwise a sensible error will be produced. In general, the ice point is lower in the vertical position of the thermometer than in the horizontal position; it is therefore well to determine both ice points.

Second. The determination of the boiling point: This requires the use

of pure distilled water, in the absence of which melted snow or rain-water may be used; the thermometer is to be placed in a receptacle, so arranged that the reading of thermometers may be taken when the whole is surrounded by an atmosphere of steam; and the tension of the vapor thus surrounding must be very accurately known; for thermometers whose ice point shows a strong depression after heating, the boiling point also shows a small depression up to one-tenth of a degree. In order to be sure, it is necessary that the boiling-point determinations should be repeated from time to time with the freezing-point determination between, until the maximum depression of the ice point has become constant, when the boiling point will also become constant. In case the place of observation is changed, it is necessary to introduce a correction for the variation of gravity. The International Committee of Weights and Measures have recently determined to adopt as the unit of pressure that of a weight of a column of mercury of normal density, temperature  $0^{\circ}$ , and height of 760 standard millimeters at the latitude of  $45^{\circ}$ , and at the level of the sea.

Pernet proposes, in connection with this, to call the temperature of boiling water corresponding to this normal pressure,  $100^{\circ}$  C. (equal  $212^{\circ}$  F.), and thus also to obtain a uniform unit for the measurements of temperature, instead of accepting as the unit of absolute pressure two different mercurial columns in the laboratories at Kew, London, and Paris. Every warming of the thermometer brings a new change in the freezing and boiling points. The maximum depression which is attained after many years of quiet and many days in ice can be expressed by the following formula:

$$d = \frac{D \times t^2}{100^3}$$

where  $d$  is the maximum depression for given temperature ( $t$ ),  $D$  the maximum depression for  $100^{\circ}$  C., both computed for thermometers that have remained a long time in the ice. In general the thermometers made of French glass show smaller depression than those made of Bohemian glass. (*Z. O. G. M.*, XIV, 1879, p. 134.)

Thiesen remarks that the method of calibration of thermometers taught by Professor Neumann has considerable advantages over that of Bessel. Let  $0, 1, 2 \dots n$  be points equally distant from each other on the thermometer scale whose corrections are to be directly determined, (the so-called principal points,) and let  $\Delta_0, \Delta_1, \dots \Delta_n$  be the corrections for these points. Let the corrections of the intervals between the principal points, the so-called principal intervals, be  $\vartheta_1, \vartheta_2, \dots \vartheta_n$ , so that in general  $\vartheta_i = \Delta_i - \Delta_{i-1}$ . The mercurial threads to be used for calibration should now be so chosen that they as accurately as possible include a whole number of principal intervals. If now the upper end of such a thread be in neighborhood of a principal point  $i$ , then will the lower end be opposite a principal point  $k$ . The volume of such a thread can be expressed by  $f_{i-k}$ ; its apparent length in

the given location—that is to say, the difference in the readings of the upper and lower ends—can be indicated by  $(i, k)$ . If, now, we neglect the corrections of the short intervals that lie between the ends of the thread and the principal points between  $i, k$ , then we have the relation  $f_{i,k}$  equals  $\Delta i - \Delta k + (i, k)$ . If we now shove the thread so that its ends come in the neighborhood of other principal points, then we have new equations in which the left-hand side is the same, but on the right-hand side in place of  $i, k$  we have successively  $i-1, k-1$ ;  $i-2, k-2$ . If, now, we subtract each equation from the ones following it, then we have a new series of equations that may be represented by  $\vartheta_1 - \vartheta_k = (i-1, k-1) - (i, k)$ . The sum of all the left-hand side of this equation must disappear. (*Z. O. G. M.*, XIV, p. 426.)

Pernet has investigated a method of computing the variations of freezing points of thermometers. He says that the case often occurs that no ice is conveniently at hand for the determination of the freezing point before and after the measurement has been made of some high temperature; but even then one can determine the variation of the freezing point with a degree of accuracy that is generally sufficient, provided that we know the freezing point as affected by the change from zero to 100° centigrade, and the temporary freezing point—that is to say, the freezing point corrected for the depression depending on the time—that is to say, on the exposure of the thermometer for a long time to the temperature of the room, and which depression is usually proportional to the time. This last condition is generally fulfilled for thermometers that are more than six months old, or even in a shorter time if the thermometer has been slowly cooled down after its determination of the boiling point. Let  $\tau$  be the reading of the thermometer corrected for the caliber and the value of the degrees; let  $c$  be the temporary depression of the freezing point and  $\gamma$  be the maximum depression of the freezing point for the range from zero to 100° C.; then, after a long warming at the temperature  $\tau$ , we have the true temperature given by the following formula:

$$T = \tau - c + \frac{(c - \gamma)\tau^2}{100^2}$$

If, now, we pass directly from these comparisons to such as are made at steadily increasing temperatures  $\tau_1, \tau_2$  without allowing the thermometer to cool down in the mean time, then this formula holds good for the higher temperatures, and we simply substitute  $\tau_1, \tau_2$ , &c., for  $\tau$ . But this formula does not hold good if between two series of observations the thermometer has ever been exposed to low temperatures. In this case a new temporary freezing point  $c_1$  must be used as the starting point. (*Z. O. G. M.*, Vol. XIV, p. 206.)

Winstanley has given his radiograph a form convenient for continuous self records. The instrument consists essentially of an air thermometer, having its bulbs bright and black, respectively. The tube connecting these is bent around a brass circle, so that the bulbs or res-

ervoirs are quite near together and exposed to the radiation of the sun and sky. The counterpoise is so attached to the brass circle that the latter comes to rest in an initial position, and any disturbance from this position is shown by the motion of an index. The lower half of the circular glass tube is filled with mercury, and the differential expansion of the air in the two bulbs, by altering the position of this mercurial column, causes the entire apparatus to rotate around the axis of the circle. (*Z. O. G. M.*, Vol. XV, 1880, p. 493.)

Pictet and Cel  rier have constructed a form of thermo-dynamometer which can be used as a very sensitive self-recording thermometer. The thermometric substance adopted in this instrument consists of a saturated vapor of some volatile liquid, which substance varies according to the temperature that is to be measured. Thus, for a range of  $-40^{\circ}\text{C.}$  to  $+25^{\circ}\text{C.}$ , pure anhydrous-sulphuric acid; for the range  $+25^{\circ}\text{C.}$  to  $+90^{\circ}\text{C.}$ , sulphuric ether; for the range  $+90^{\circ}\text{C.}$  to  $+200^{\circ}\text{C.}$ , distilled water. These fluids are introduced into an inclosed space, L; the vapors press upon the mercury in the manometer at M; and the tension of the vapor is shown by the height of the mercurial column MM. The tension of the vapor depends upon the temperature of the mixture of fluid and vapor, as shown by the following equation:

$$\log. \text{ nat. } \left( \frac{P'}{P} \right) = \frac{\lambda' + (c-k) (t' - t) 431 \times 1.293 \delta 274 (t' - t)}{10333 (274 + t') (274 + t)}$$

In this equation P and P' are the vapor tensions corresponding to the two temperatures  $t$  and  $t'$ , of which  $t$  is the temperature to be measured and  $t'$  an arbitrary constant temperature;  $c$  is the specific heat of the fluid, and  $k$  the specific heat of its vapor;  $\delta$  is the variable density of the vapor;  $\frac{1}{274}$  is the coefficient of the expansion of gases; 10333 is the pressure on a square meter of a column of mercury 760 millimeters high; 431 is the most probable value of the mechanical equivalent of feet as deduced by Pictet from Regnault's data.

In the apparatus constructed by these authors for the observatory of the city of Geneva, the ordinary range of temperature,  $-20^{\circ}\text{C.}$  to  $+40^{\circ}\text{C.}$ , is represented by a motion of the mercurial column of more than 4 meters, which is represented upon the graphic paper record by the motion of about one-half a meter. (*Z. O. G. M.*, XIV, p. 248.)

The hygrometer designed by Edelmann, and constructed at his physical mechanical institute at Munich, depends upon the principle that when a given space is filled with moist air, and the vapor is absorbed therefrom without altering the volume, then the pressure diminishes by quantity equal to the tension of the vapor contained in the air. The principal portion of Edelmann's apparatus consists of a horizontal cylinder, closed at both ends with corks, through which pass tubes for the entrance of the air outside, and which also connect with the manometer. The method of making a measurement is as follows:

First, make the entire apparatus clean and dry; second, place the

air-box in its metallic case and insert within it the two glass tubes connected with the drying apparatus and the manometer, respectively. By suction the air within the chamber is withdrawn and replaced by fresh air from the place of observation. After reading the barometer, the air within the chamber is dried by sulphuric acid, after which the barometric pressure within the chamber is again determined. The results of this simple and convenient apparatus are absolutely correct and reliable, as has been shown by many series of experiments, and as also appears from the entire arrangement of the apparatus and the principle adopted in it. This apparatus serves for independent, accurate hygrometric observations, and the verification of the results given by psychrometers and other less reliable instruments. (*Z. O. G. M.*, XIV, 1879, p. 56.)

The patent hygrometer by Professor Klinkerfues has been studied by Dr. Müttrich. This instrument consists of two hygroscopic threads, or hairs, a thermometer to determine the temperature of the air, and a disk for determining the dew-point. Müttrich finds that large errors in the relative humidity occur during various portions of the same day, and the instrument does not correspond to the requirements of meteorology. (*Z. O. G. M.*, Vol. XV, 1880, p. 170.)

Rudorff has made a comparative study of the methods of determining the aqueous vapor present in the atmosphere. The Schwackhofer apparatus, on account of its high price and complication, seems to be less desirable than that devised by Edelmann, in which from a given quantity of air the aqueous vapor is absorbed by sulphuric acid, and the diminution of atmospheric pressure is measured by means of a manometer. But a still simpler apparatus is that devised by Rudorff himself. In this a given quantity of air is inclosed in a given chamber; the aqueous vapor is then absorbed from the air, and consequently the pressure in the chamber is diminished. This change in pressure can now be counteracted by the gradual addition of sulphuric acid until the original pressure is reproduced, and the absorbed aqueous vapor is thus replaced by an equal amount of sulphuric acid, which volume can, of course, be easily measured. The apparatus allows of the determination of the volume or weight of the aqueous vapor to within 1 per cent. (*Z. O. G. M.*, Vol. XV, 1880, p. 168.)

Dines has studied the experimental investigation of the rainfall as observed on various corners of a square tower. Gauges were placed at the NE., SW., NW., and SE. corners. He concludes that the ratio of total rainfalls on the tower and on the earth depends on the direction and strength of the wind. In calms the differences are scarcely sensible. For a given wind direction the rainfall varies with each position on the tower. The locations which lie on the side next to the wind receive less rain, those on the opposite side receive more rain than if on the surface of the earth. The excess of one side balances the deficit of the other, but whether the mean of both is equal to the true rainfall is not decided. (*Z. O. G. M.*, XIV, p. 450.)

Riegler, in a discourse before the Austrian Meteorological Association, has urged the wider introduction of Piche's evaporimeter. The necessity of some form of this instrument has been widely felt, but none of the many devices have given satisfaction, or have been considered as much better than local experiments. The comparison and study of these instruments (especially that of Piche) have been especially undertaken by Dr. Lorenz. The apparatus is made by Baudin and Tonnelot, in Paris, and its prominent feature is a long glass tube, about one centimeter in diameter, which is closed above, and hangs from a hook, while the lower end is open and ground off to a plane surface. On this glass tube a scale is etched. The tube being filled with water, and the lower end closed by a thin piece of filter paper, in which, if necessary, fine needle holes have been pricked, the instrument is hung up in an exposed place, and the amount of the continual evaporation of water from the paper surface is easily determined by reading from the scale etched on the tube.

The inventor originally assumed that the evaporation from the wet-paper surface is the same as from the free surface of water. But this is not strictly true; and the relation between the indications of any Piche instrument and a normal evaporimeter must be determined by comparative readings; especially does the small size of the tube allow the water therein to become easily heated, so that these instruments in general have a much larger evaporation than the normal or standard, which consists of a large cylinder of water established in a shady spot, and so sunk within a still larger mass of water that the inner vessel retains a uniform temperature.

Riegler states that his experiments have shown the necessity, on the one hand, of accurate observation of the temperature of the surface of large areas of water; and further, that we must relinquish our attempt to keep the water in our evaporimeter exposed under so-called natural conditions, for we cannot possibly define what those conditions are.

Not only is the Piche evaporator affected too easily by an excess of temperature, but it is also liable to be troubled by atmospheric electricity, and is, of course, utterly useless when the temperature falls below freezing. These disadvantages partially counteract the great advantage of simplicity of construction, and accuracy of its readings; and it is to be hoped that, at least during the warmer portion of the year, this cheap and simple instrument may be widely introduced.—(*Z. O. G. M.*, XIV, p. 370.)

The brief description given in 1878 of Nipher's modification of the rain-gauge has been supplemented by the publication in full of his original paper read before the American Association for the Advancement of Science. Already in 1861 Jevons had clearly explained that any resistance experienced by a current of air forces the latter to flow over the sides and surface of the obstacle with increased velocity; consequently the drops of rain that in the absence of this disturbance would have

fallen into the rain-gauge are diverted from their paths, and some of them fall to the leeward. Jevons concluded that measurements of rainfall made with gauges that are high above the ground, and exposed to the wind, are entirely useless. The observations made by the rainfall committee of the British Association, as communicated in their report in 1870, confirmed Jevons's explanation. They found that the greatest rainfall was measured in gauges that were so sunken within pits in the earth that the mouth of the receiver was on a level with the earth's surface, and entirely protected from violent wind currents, and their recommendation of the so-called pit-gauge has generally been considered our best knowledge on the subject. But another form for the gauge was suggested by Jevons in 1861, in which the mouth of the receiver is surrounded by a large horizontal metallic disk. This form has been modified by Messrs. Nipher and Woodward, by the introduction of cells, and finally simplified into a simple upright tube, surrounded by a protecting screen in the general shape of a filter, whose broad lip protects the mouth of the receiver from gusts of wind. Two rain-gauges, one without and the other with the protecting lips, were exposed side by side during a summer and spring, and the unprotected gauge collected 3 per cent. less than the protected one. In the experiments of the British Association an unprotected gauge, in a similar position, collected five per cent. less than the pit-gauge. Again, sixteen gauges with protecting lips were placed in various locations on the roof of the university building in Saint Louis, a hundred feet above the earth.

The result of these experiments is to show that the so-called correction, for the altitude of the rain-gauge reduces to nothing when the gauge is properly protected against the wind, and that under this condition the rain-gauge may be safely established at any altitude whatever. (*Z. O. G. M.*, XIV, p. 250.)

Köppen has attempted to apply the results of Dohrandt's investigations into the accuracy of the Robinson anemometer to the reduction of the observations made at the stations of the German Marine Observatory. According to Dohrandt the true velocity ( $w$ ) of the wind can be derived from the velocity ( $a$ ) of the centers of the hemispherical cups of the Robinson anemometer by the formula  $w = K + B a$ , where  $K$  and  $B$  are constants peculiar to each instrument. In the absence of any special determination,  $K$  may be assumed equal to 1.0 meter per second, which is the mean of the values determined by Dohrandt for the anemometers and anemographs investigated by him.

The constant  $B$ , which, according to Robinson, should be equal to 3.0, can be more accurately computed by Dohrandt's empirical formula

$$B = 3.0133 - 53.7367 \frac{R^2}{r} + 1033.81 \frac{R^4}{r^2}$$

where  $R$  is the radius of the hemispherical cups and  $r$  the distance of the centers of the cups from the axis of rotation, both expressed in



meters. For the anemographs furnished to the German stations the computed value of  $B$  is 2.396, whence their formula for computation of true wind velocity is  $w=1.0+2.396 \times a$ . This formula has been abundantly verified by comparison between the anemometer at the Seewarte and the small normal anemometer in the possession of Professor Recknagel. We can, therefore, assume that the wind velocities ( $w$ ), computed for the German stations under the ordinary assumption that  $B=3$ , must be reduced to true wind velocities ( $w^1$ ) by the formula  $w^1=1.0+0.8w$ . This relation may also be expressed by the following table:

Velocity by German anemometers.	Corrected true wind velocity.
0.5	1.4
1.0	1.8
2.0	2.6
3.0	3.4
4.0	4.2
5.0	5.0
10.0	9.0
15.0	13.0
20.0	17.0
25.0	21.0
30.0	25.0

The comparison between the estimates of force made by the German observers and the anemometric velocity recorded at the same stations has been made by Dr. Sprung for about a thousand observations at each of four stations, and the anemometric velocities can be converted into true velocities by the preceding formula, as in the second and third columns of the following table; and if we treat in a similar way the observations that were made in England and discussed by R. H. Scott, we have the values given in the fourth and fifth columns of the table:

Four German stations.			Three English stations.	
Estimated Beaufort scale.	Anemometric velocity.	Corrected velocity.	Anemometric velocity.	Corrected velocity.
0	1.10	1.9	2.2	2.1
1	2.12	2.7	3.8	2.9
2	3.72	4.0	4.9	4.2
3	5.48	5.4	6.4	5.8
4	7.25	6.8	8.2	6.9
5	9.01	8.2	10.5	8.7
6	10.99	9.8	13.0	10.7
7	12.15	10.7	15.5	12.7
8	14.28	12.4	17.7	14.5
9	17.42	14.9	19.8	15.7

The mean of the English and German observations is represented with considerable accuracy by the following formula, where  $m$  indicates the scale number of the Beaufort scale:

$$w=1.66 + 1.12 \times n + 0.045 \times n^2$$

The observers at Russian stations rarely estimate the wind velocity, but observe the angles of deviation of Wild's tablet anemometer, which are converted into the Beaufort scale before being telegraphed. They may therefore be converted into true velocities by means of Dohrandt's investigation of the normal tablet anemometer at St. Petersburg, and the scale of velocities adopted by R. H. Scott, as shown in the following table:

Meters per second by Wild's tablet anemometer.	Scale number of the Russian telegrams.	Corresponding cor- rected Beaufort's scale number.
1.5	0	0
3.5	1	1.5
6.0	2	3.5
8.0	3	5.0
10.0	4	6.0
12.5	5	7.5
15.0	6	9.0
18.0	7	?
21.5	8	?
25.0	9	?

(Z. O. G. M., XIV, p. 304.)

The construction of lightning-rods, and the statistics of injury by lightning, have been discussed by Richard Anderson, who states that in England one-half or two-thirds of public buildings are without lightning rods, and that of private buildings, not five in a hundred are provided with them. The injury annually done by lightning is very great, as also the number of lives lost through its means. We are within bounds when we estimate that in England and Wales there are on the average as many deaths from lightning as there are in Prussia, for which we have accurate data, and the sum total for all three countries amounts to one hundred and fifty persons. The reason of this loss of life lies not only in the omission to erect lightning-rods, but from the poor character of those which are often put up, and also in the neglect to carry out a system of inspection in order to insure that the rod continues to be still in good working order. Thus it seems incredible, but it is a fact, that the royal castle at Windsor is almost entirely without lightning-rods, and in some portions is provided with those too small to be of any use. Many come to the erroneous conclusion that lightning-rods are of no use, but this is due to their improper construction and insufficiency of numbers. As regards their inspection, it would seem remarkable that every part of a large building is annually repaired, painted, &c., while a lightning-rod, when once established, is never looked after, and yet its efficiency can be injured at any moment to such an extent that it may become a source of danger rather than a safeguard to the building. (Z. O. G. M., XIV, p. 65, 1879.)

Dr. Paul Schreiber, whose improvements in the self-recording balance barometer are above noticed, states that he has been able in the instrument established at the Deutsche Seewarte to reduce the uncertainty of the record (due principally to frictional resistances) to  $0.2^{\text{mm}}$ ; but,

desirous of making the instrument fully respond to the demands of the present state of barometry, he proposes a new form which will, he thinks, be more entirely free from errors depending on time and circumstances. He proposes to substitute some form of hydrostatic flotation for the balance beam, having found that a remarkable constancy attends the measurements of bodies floating in mercury, while the friction is reduced to an inappreciable quantity.

The device for registration (namely, a pencil or point pressed against a sheet of paper continuously, or at regular intervals, by clockwork) offers still some difficulty, which, however, can, we suggest, probably be removed by introducing the features of Thompson's electric pen, as used with the Atlantic cable. Schreiber suggests photography, and also glass plates covered with lamp-black, as a means of recording the observations. He gives a complete mathematical exposition of the theory of the corrections to this new form of instrument and shows that all constants and all sources of error can be determined in the instrument itself, thus making it an independent standard and not an interpolation barometer. Where the influence of temperature is large, it can easily be computed. (*Z. O. G. M.*, XVI, 1881, p. 497.)

Kohlrausch has suggested some improvement in his method of making absolute measures of the intensity of terrestrial magnetism by the galvanic method; in its latest form he overcomes the difficulties due to the large dimensions of the instrument, the necessity of knowing the curvature of the surface of the coil of wire, the determination of its moment of inertia, and the accurate determination of the time. The full description of his methods will be found in the "Nachrichten" of the Scientific Association of Göttingen, June, 1881. His method commends itself especially in that observations of magnetic variation and the duration of the vibrations are unnecessary; it will probably be adopted by several of the observers on the international stations for Polar research. (*Z. O. G. M.*, XVI, p. 473, 1881.)

Sworikin has made an excellent study as to the reliability of the psychrometer constant (A) and the effect of the velocity of the wind. He has used the Alluard dew-point apparatus and the Schwack hofer volumetric hygrometer as his standards of comparison. Belli, Regnault, and Chistoni had all shown that a regular gentle current of air is essential to accuracy. Sworiken concludes: (1.) That the best value of the constants give the following formula:

$$x = t' - 0.000725 (t - t') B.$$

(2.) That the same formula applies for  $t'$  below as well as above freezing, contrary to the theories of August and Regnault. (3.) For wind velocities of 1.5 to 2.0<sup>m</sup> per second (3 to 4 miles per hour) the best results are obtained (4) that the computed tensions of vapor are accurate to within 0.1<sup>mm</sup>. (*Z. O. G. M.*, XVI, 1881, 434.)

Dr. M. Thiesen has published, among the metronomical contributions

of the imperial German commission on standards of measure, an exhaustive memoir on the comparison of mercurial thermometers. In his last chapter he gives a collection of his results that may well form the basis of a reformation in every meteorological service that has not already attended to this important subject. He gives formulæ for computing the changes in zero point of a thermometer depending on time and on the exposure to high or low temperatures. The requirements of a good thermometer are given by him in great detail; among them we note an item frequently overlooked, namely, the importance of selecting the proper kind of glass; it having been shown that thermometers of the same glass behave similarly in respect to the reduction to absolute temperatures or the air-thermometer, and also similarly in respect to the changes with time and temperature. Especially happy would it be if there could be introduced glass such as that used in the construction of one thermometer investigated by Dr. Thiesen, which during the past fifty years has experienced no sensible change in its fiducial points, and whose temporary variations with temperature are but one-fourth of those experienced by other thermometers, and whose corrections to reduce to the air-thermometer are remarkably small. The effect of changes in external pressure (as in a liquid bath, or with a varying barometer) is appreciable and is therefore not to be neglected. Dr. Thiesen for the first time separates the error of graduation of the scale from the error due to the lack of uniformity of the tube as found by calibration.

He adopts as the temperature of  $100^{\circ}$  C. that which is now coming to be recognized by the meteorologists and physicists—namely, the temperature of saturate pure aqueous vapor under a pressure of a column of mercury 760<sup>mm</sup> high at zero C., in latitude  $45^{\circ}$ , and at the sea level; thereby relinquishing the objectionable adoption by meteorologists of Regnault's laboratory as the normal locality. (*Z. O. G. M.*, XVI, 1881, p. 290.)

T. H. Stevenson has observed the effects on the velocity of the wind of nearness to the earth's surface, by establishing an anemometer on a staff fifty feet high. He finds the increase with altitude very regular between 15 and 50 or more feet and represents the velocity by the ordinates of a parabolic curve, the abscissas of which are the heights reckoned from an horizontal axis 72 feet below the surface of the earth. It follows that all anemometers ought to be at a uniform height and not less than 20 feet above the ground.

From the known velocity ( $v$ .) at a known height ( $h$ .) we can approximately compute the velocity ( $V$ .) at any other height ( $H$ .) by the formulæ,

$$V = v \frac{H + 72}{h + 72}$$

where, however,  $h$ . must be more than 15 feet and  $H$  not much more than 50 feet. (*Z. O. G. M.*, XVI, 1881, p. 310.)

Voller, in the proceedings of the Scientific Society of Hamburg-Al-S. Mis. 109—17

tona, describes an improvement upon Edelmann's absorption hygrometer and gives the formula for computation of the tension of vapor, as well as observations showing the accuracy of the apparatus. (*Z. O. G. M.*, XVI, 1881, p. 319.)

M. de Lepinay has made a further study of the effect of wind velocity upon the whirling psychrometers (thermomètre à froude). He finds that for pressure of 758<sup>mm</sup>, and temperature from 7° to 20° C., the formula

$$f' - f = 0.525 (t - c')$$

very closely represents the vapor tensions observed with the dew-point apparatus. (*Z. O. G. M.*, XVI, 1881, 217.)

Höttinger & Co., of Zurich, have adapted a self-register to a Weilemann or Goldschmid aneroid, and the apparatus has now been tried with great success at a number of European stations. An automatic compensation for its own temperature is introduced and the whole mechanism is of the simplest possible construction; it goes for ten days without attention. In comparison with other forms of registering barometer, it will be found that the present one is more easily transported and established in its place. The wooden base is replaced with a metal one with adjusting foot-screws; the five vacuum-boxes are, as before, supported vertically one above the other, but they are now held in this position by a strong spring that prevents accidental changes due to the slight shocks received in transportation. The scientific value of the records of three of Höttinger's barographs has been studied by A. Wolfer, assistant at the observatory in Zurich, who subjected them to large changes in temperature and pressure, and upon comparing their records with simultaneous readings ( $b_0$ ) of the mercurial barometer found the following results, where  $t$  is the temperature and  $x$  the arc through which the pencil moves and whose versed sine is the quantity measured on the record sheet.

$f(x)$  is the computed reduction for the curvature of the arc, and is nearly the same for all instruments, and may be taken from a table, such as the following.

$x$	$f(x)$
-20	-0.15 <sup>mm</sup>
0	0
+20	-0.15

The formula for barometer No. 11 is  $b_0 = 0.00^{\text{mm}} - 0.995 \times + 0.1 (+ - 60^{\circ} \text{ F.}) + f(x)$ . The probable error of one reading of the mercurial barometer was  $\pm 0.1^{\text{mm}}$ ; and that of the corrected barograph reading was no greater.

For barometer No. 12 the corresponding formula was almost identically the same, and the probable error of a single reading was  $\pm 0.15^{\text{mm}}$ .

No. 13 was studied most minutely and the values of the constants determined for all pressures and temperatures, thus providing for its being

used at elevated stations; the co-efficient of  $x$  varied from  $-1.199$  at  $780^{\text{mm}}$  to  $-0.920$  at  $400^{\text{mm}}$ . (*Z. O. G. M.*, XVI, 1881, p. 273.)

Pernter has given excellent rules as to the use of the aneroid, and urges that observers be not misled by these elaborate inquiries into considering the aneroid as an independent instrument, but that it must retain its place as a means of interpolation only and that the mercurial must be used daily as a check; the instrument is always received after the degrees of low or high pressure have been marked upon it. (*Z. O. G. M.*, XVI, 1881, p. 273.)

Höttinger & Co. have also constructed a self-recording thermometer and hygrometer that, as well as their barometer, commend themselves on account of their simplicity, accuracy, and convenience. There are three examples of the apparatus being investigated at the Zurich Observatory; through a small range of temperature and moisture it gave the following results:

One degree of temperature is represented in the records by  $2.38^{\text{mm}}$ ,  $3.2^{\text{mm}}$ ,  $1.6^{\text{mm}}$ , respectively.

The mean discordance of the corrected records was  $\pm 0.12^{\circ}$ ,  $\pm 0.14^{\circ}$ ,  $\pm 0.18^{\circ}$  C., respectively.

For the hygrograph the mean errors for the percentages of relative humidity were  $\pm 1.2$ ,  $\pm 1.7$ ,  $\pm 1.6$ , respectively. (*Z. O. G. M.*, XVI, 1881 p. 283.)

Colding has endeavored to ascertain the true velocity of the wind by careful observation of the paths of definite masses of smoke issuing from tall chimneys. For Copenhagen during 1878 and 1879, he finds the average velocity  $5.5^{\text{m}}$  per second; the anemometer records at neighboring coast stations of the Deutsche Seewarte give  $5.1^{\text{m}}$  and  $5.5^{\text{m}}$ .

Observers in favorable localities would do well to supplement their own records by this class of observations, it being well known that the wind force and direction at a few hundred feet altitude is very different from that at the ordinary level of observers and anemometers. (*Z. O. G. M.*, XVI, 1881, p. 270.)

Maxwell has published in the article "Diffusion" in the ninth edition of the "Encyclopædia Britannica" an original demonstration of a formula for the wet-bulb thermometer based on the assumption that the surrounding air is quiet and that the dissipation of heat and vapor takes place wholly by processes of radiation, conduction and diffusion; whereas, August and Regnault based their formulæ on the assumption that the principal agency is convection due to air-currents. Maxwell is led to the following formula:

$$p_0 = p_1 - \frac{TS}{L\sigma} \left\{ \frac{K}{D} + \frac{AR}{4\pi C\rho SD} \right\} (\theta_0 - \theta_1)$$

where  $p_0$  is the desired tension of vapor in an atmosphere whose temperature is  $\theta_0$ , and  $p_1$  is the tension corresponding to the temperature  $\theta_1$  of the wet-bulb.  $P$  is the prevailing barometric pressure, and the other

symbols are constants relating to the thermometers, the specific heat, &c. In its general form, therefore, this formula agrees nearly with that of Apjohn which was based upon an imperfect convection theory. Maxwell's theory gives us a clear view of the significance of the numerical co-efficients. In reproducing Maxwell's theory above mentioned, Hann takes occasion to publish the views of Prof. J. Stefan, as partially given by the latter in 1873, in his "Versuche uber die Verdampfung," and now more fully communicated by him. Stefan's theory is similar to that of Maxwell, but his numerical constants are more carefully determined especially by means of his own extensive researches into the laws of conduction, radiation, evaporation, and diffusion: He finds the  $\frac{K}{D}$  or  $\frac{K^1}{D}$  in the above equation to be equal to 1; R varies from 0.000087  $\theta$  for glass, to 0.000097  $\theta$  for water. (*Z. O. G. M.*, XVI, page 177, 1881.)

Chistoni has published two memoirs upon the modifications of Regnault's formula for wet-bulb thermometer that have been proposed by Belli and others. The form at first examined by Belli himself is as follows:

$$f = \frac{f' - (a B - b)}{f - f'} - \frac{(a B - b)(t - t')}{C - d \theta}$$

but the formulæ and constants of Regnault and August equally with this fail to perfectly represent the exact amount of aqueous vapor; and finally, in his second dissertation, Chistoni concludes that the following modification of the formulæ of Belli

$$f = \frac{f' - m(t - t')(B - f')}{1 + \frac{n}{B}(t - t')(B - f')}$$

gives it quite as accurate as can be desired. (*Z. O. G. M.*, 1881, XVI, p. 82.)

Jordan has described a new glycerine barometer, which is therefore sensitive in proportion to the difference between the densities of glycerine and aniline. One such barometer is now in the observatory at Kew, another is established in the museum for practical geology at Jermyn street, a third is in South Kensington, and a fourth is in the office of the London Times. (*Z. O. G. M.*, Vol. XVI, 1881, p. 26.)

Sprung has described and elaborated a theory of a self-recording balance barometer, in which a weight supported by a chain replaces the bent-lever arm of Wilds's and other forms of this apparatus. Ordinarily the barometer tube or its cistern moves up and down in order to register the variations of its pressure, but in the present instrument this movement is replaced by that of an auxiliary mechanical arrangement entirely independent of the physical apparatus. As manufactured by Fuess, this barometer of Dr. Sprung is said to give excellent results. (*Z. O. G. M.*, Vol. XVI, 1881, p. 1.)

Dr. Wagener has devised an apparatus for recording certain features of earthquake shocks, namely: The time, the greatest horizontal motion, both amount and direction. During the first three months of its working, it recorded eleven earthquakes at Tokio, Japan, and this experience would seem to demonstrate the practical value of the apparatus. The horizontal movement of a point on the earth's surface is about  $0^{\text{mm}}.05$  ( $\frac{1}{800}$  inch) in the case of earthquakes that are scarcely perceptible; but is  $0^{\text{mm}}.8$  ( $\frac{1}{30}$  inch) for earthquakes of moderate intensity. (*Z. O. G. M.*, p. 102, Vol. XV.)

#### IV.—CHEMICAL AND PHYSICAL PROPERTIES OF THE ATMOSPHERE.

Jolly has investigated the variability of the chemical constitution of the atmosphere by two methods, both by the balance and endiometer. His published measures were made from 1875 to 1877, and give the following results: The percentage of oxygen computed for the extreme cases was 20.965 at the maximum, and 20.477 for the minimum, or a variability of  $\frac{1}{100}$  of one per cent. The polar current, if it continues for a season, brings a higher percentage of oxygen, and the equatorial current a lower percentage. The eudiometric method was used as a check upon these results, and gave a maximum of 21.01 per cent. and a minimum of 20.53 per cent. The proposition as to the constancy of the constitution of the air is therefore untenable; and Regnault suspected rightly when he declared it deceptive to so accept the air as a unit for the specific gravity of gases.

The important question now arises, What are the variations in the constitution of the air, and what their causes? Jolly believes that the smaller percentage of oxygen in the equatorial current arises from the fact that in the tropics and subtropics, in spite of the greater vegetation, the oxidation exceeds the reduction, while in the Polar regions the contrary is the case. (*Z. O. G. M.*, XIV, 1879, p. 228.)

Soret has communicated some preliminary results from an incomplete investigation into the law of radiation at high temperatures, which investigation had as its object to show how far in such cases the Dulong-Petit law deviates from the truth. A platinum wire, measuring 0.31 millimeters in diameter and 385 millimeters long, is, by means of an electrodynamic machine, heated to the melting point. This machine is driven by a hydraulic motor whose normal strength is 4 horse-power, or a working force of 18,000 kilogrammeters. This work is equivalent to an increase of temperature of 42.3 calories. If, now, we assume that the whole work in the electric current is converted into heat which is applied to the heating of the platinum wire, then the latter can in one minute receive not more than 42.3 calories.

But on the trial the platinum wire melted in a few seconds and broke into pieces—the study of which showed that the wire was melted throughout its whole length. Therefore the wire had attained the temperature of melting platinum in every part, which temperature must have been



at least  $1,700^{\circ}$  C. The superficial area of the wire at this temperature must have been 385 square millimeters, for which we will use 300 in order to take account of the cooling at both its ends. If, now, we compute the quantity of heat in calories radiated from this surface at this temperature, according to the law of Dulong-Petit, assuming the radiating power of polished platinum to be 0.092 according to La Provostaye and Desains, then we find for the whole surface 145.623 calories, whereas, according to the computation of the electro-motive force, it was impossible that more than 42.3 calories could have been delivered. The difference is enormous and is equally so in other cases. (*Z. O. G. M.*, XIV, p. 229.)

Soret has investigated the absorption of heat by the earth's atmosphere, and the following review of his measures is given by Pictet. The apparatus used by Soret is very similar to that subsequently used by Violle in his investigations upon similar subjects. Moreover, Violle selected the dynamic method and Soret the static method of observation. Soret finds that the variable absorption that our atmosphere exerts upon the solar rays appears to be a consequence of the variation in the quantity of aqueous vapor, as well as the variable quantity of dust, smoke, &c. All observations show plainly the influence of aqueous vapor upon the absorption of the rays of heat, and other things being equal the absorption is greater in proportion as the quantity of aqueous vapor is greater. Thus :

(a) In winter, when the air is drier, the radiation is notably more intense than in summer for an equal altitude of the sun. [Violle differs from Soret in this item, but Secchi agrees with the item.]

(b) If we group the observations made with equal altitudes of the sun, according to the degrees of humidity at the time of observation, we find the intensity of radiation greater the drier the air is.

(c) Frequently a greater intensity of radiation is shown with dry air than when with moister air the atmosphere is undeniably much purer and more transparent.

(d) The maxima of the intensities of the radiation correspond ordinarily, especially in summer, to exceptionally cold and dry days—for instance, during or immediately after prevailing strong north winds.

The absorbing influence of suspended solid particles of organic and inorganic matter is undoubted. This influence is felt over all the rays, especially, however, over the most refractive.

The absorbing power of the aqueous vapor is felt especially by the less refractive rays. The annual maxima occur most frequently early in spring, for in this time of year all the more favorable circumstances are united—a considerable solar altitude, dry air, and a small quantity of dust particles.

The radiation is more intense for considerable altitudes than near the horizon. The maximum of the day occurs a little before midday for the high altitudes, while for lower altitudes it occurs somewhat after midday.

For equal thicknesses of the atmosphere penetrated by the rays the radiation on high mountains is more intense than on the plains, contrary to what Forbes had deduced by his own observations; hence, it follows that the lower stratum of air acts with greater absorbing power than the upper stratum, as is also explained by the greater mass of aqueous vapors, as well as by the greater accumulation of dust in the lower portions of the atmosphere. (*Z. O. G. M.*, XIV, p. 312.)

Reiset, as the mean of a number of observations during the years 1872-79, comes to the conclusion that the air of the free atmosphere contains on the average 0.02942 of one per cent. of volume of carbonic acid gas. The extreme variations of his measures do not exceed 0.03. (*Z. O. G. M.*, XIV, p. 452.)

Hasselbarth and Fittbogen, from observations in 1874 and 1875, conclude the following to be the volume of carbonic acid gas in the air:

January .....	3. 26	July .....	3. 31
February .....	3. 22	August.....	3. 40
March.....	3. 41	September....	3. 41
April .....	3. 43	October .....	3. 34
May .....	3. 30	November .....	3. 43
June .....	3. 31	December ....	3. 25

The largest variations in the quantity of carbonic acid are apparently due to the variations of the wind. An increase in the wind is followed by a diminution of the carbonic acid. Rain usually causes a depression, but after thunder storm an increase in the quantity is usually noticed. (*Z. O. G. M.*, XIV, p. 452.)

Schultze has observed the same property in Rostack, and the following table shows the means of his observations:

January .....	2. 90	July .....	2. 90
February .....	2. 90	August.....	2. 88
March.....	2. 99	September....	2. 90
April .....	2. 97	October .....	2. 95
May .....	2. 94	November .....	2. 86
June .....	2. 92	December ....	2. 84
Year .....			2. 91

(*Z. O. G. M.*, XIV, p. 453.)

J. L. Schönn states that, having obtained a very perfect prism from Hilger, in London, he examined water and other substances with reference to their transmission of heat. The proportion in which the ultra-violet solar rays are absorbed by the vapor of water in the atmosphere cannot be preliminarily stated, because the ratio of the intensity of the sun's light of that special kind to the light of the electric spark is unknown, but it is still plain that the absorption of the ultra-violet is caused by the aqueous vapor. The behavior of ice is entirely different from that of fluid water; with the thickest blocks of ice (six or eight

inches) the extremest ultra-violet cadmium line is still visible. (*Z. O. G. M.*, Vol. XV, 1880, p. 57.)

Marié-Davy has published a study upon the carbonic acid gas contained in the atmosphere as observed at Montsouris, 1876 to 1879. The annual means are as follows:

Years.	Carbonic acid gas.	Clearness of the sky.
1876.....	25.9	0.63
1877.....	27.6	0.58
1878.....	31.6	0.55
1879.....	35.4	0.50

It is evident from this that of all the meteorological elements the clearness of the sky is one that has a direct connection with the quantity of  $\text{CO}_2$ , and that the ratio is such that the greater quantity of  $\text{CO}_2$  coincides with the least clearness.

Again, by comparison with the winds, it is found that the southwest bring a greater, but the northerly a smaller, quantity of  $\text{CO}_2$ . Since now the clearness cannot be directly influenced by the presence of  $\text{CO}_2$ , and since  $\text{CO}_2$  is perfectly diaphanous, like dry air, therefore Marié-Davy concludes that from the quantity of  $\text{CO}_2$  we have a means of predicting the clearness—that is to say, the weather—for a long time ahead. (*Z. O. G. M.*, XV, 1881, p. 135.)

Cornu has shown, from his investigation into the limit of the ultra-violet portion of the spectrum at different altitudes ( $h$ ) above the horizon, that the limit of visibility of the photographic spectrum, as defined by the length ( $\lambda$ ) of the last wave on the photographic plate, is connected with the altitude of the sun by the formula

$$\log \sin h = m\lambda + n$$

where  $m$  and  $n$  are two constants. For a station whose altitude above sea-level is  $z$  this formula becomes

$$\log \sin h = m\left(\lambda + \frac{z}{q}\right) + n$$

where  $q$  is a constant whose value is approximately 868.2. If, now, the absorbing power of the atmosphere is due to any substance distributed in the atmosphere according to an unknown function of the altitude, then Cornu shows that theoretically the law of absorption must be a logarithmic function of the form:  $m\frac{z}{q} = \log l - \log c$ . If, now, we sub-

stitute in this formula the value of  $m = -0.048882$ , and  $q = 868.21$ , we obtain  $z = 17761 \times \log c - \log l$ . Now the hypsometric formula is:  $z = 18336 \log b_0 - \log b$ , whence it follows that the mass of the absorbing substance is at any given altitude proportioned to the height of the barometer, and therefore has a constant ratio to the mass of the atmosphere itself.

This result points directly to the aqueous vapor as the principal absorbing substance, for the diminution of temperature of aqueous vapor with the altitude is expressed by Hann's formula:

$$z=6500 (\log f_0 - \log f)$$

We can then conclude that the aqueous vapor is not the principal absorbing substance for the ultra-violet rays, for, if we compute approximately from the co-efficients above given; we find the value of  $q$  for the absorption of the air  $q=896.3$ , a value which coincides so closely with that derived from observations (868.2), that it proves the air to be the absorbing substance and not the vapor of water. (*Z. O. G. M.*, Vol. XV, 1880, p. 444.)

Mr. E. Z. Moss has examined the air of the arctic regions microscopically, and shows that although its dust contains organic cells, yet there is every probability that these are not such as can give rise to mold, putrefaction, and disease. He finds the amount of carbonic-acid gas in the atmosphere of the arctic regions for three chemical determinations to be 0.0642, 0.0483, and 0.0536, the average being 0.0553, which is decidedly greater than in the lower latitudes. The amount of moisture in the air was also determined by him by weighing. He found, for instance, for a temperature—54.8° F. and a pressure of 29.75 inches, 118.2 liters of air contained only 0.053 grams of water. (*Z. O. G. M.*, Vol. XV, 1880, p. 492.)

Puisseux has found the following relative numbers for the actinometric effect of solar rays as observed at different altitudes in the Alps with the Arago-Davy conjugate thermometers:

Altitude.	Actinic effect.
0 meter.	1.00
830	1.09
2110	1.19
2828	1.17
3251	1.76
3380	1.78

(*Z. O. G. M.*, XVI, 1881, p. 536.)

Munter and Aubin have devised a new method of determining the quantity of carbonic-acid gas in the air, and have made a series of regular observations in Paris and its neighborhood. They find the volume to be from 2.88 to 4.22 parts of gas in 10,000 of air. The maxima occur with cloudy sky and quiet weather; the minima occur with clear sky and windy weather; the absolute maxima occurred during heavy snows and dense fogs. (*Z. O. G. M.*, XVI, 1881, p. 54.)

Armstrong has investigated the diurnal variations and the quantity of carbonic-acid gas contained in the atmosphere from 27 mid-day and 29 mid-night observations, he finds during the day 2.9603 volumes of carbonic-acid gas, but during the night 3.299 volumes in 10,000 volumes

of air, or an excess of 0.34 volumes during the night. This result agrees with the observations of Troughton, Schulze and others, and is accredited to the influence of vegetation which absorbs carbonic-acid gas during the day time. (*Z. O. G. M.*, XVI, 1881, p. 154.)

Schlösing has investigated the action of the ocean water as an absorber and regulator of the carbonic acid gas in the atmosphere. He shows that pure water in contact with the mineral carbonates, and an atmosphere containing  $CO_2$  dissolves a certain quantity of bicarbonate which increases with the tension of the  $CO_2$  in the atmosphere according to a mathematical law. The same is true of sea-water in which neutral alkalies and salt are contained; but a condition of equilibrium as to this chemical action is never attained, owing to the movement of currents and winds—only a tendency towards such is going on. When the air contains only a little of  $CO_2$  the sea gives up some and it deposits neutral carbonates; when the air contains too much of  $CO_2$  the sea absorbs and forms bicarbonates. Thus the ocean acts as a regulator, and so much the better, inasmuch as a slight calculation shows that it contains about ten times as much  $CO_2$  as the entire atmosphere, which latter may be said to be controlled by it. (*Z. O. G. M.*, XVI, 1881, p. 155.)

Lecher and Pernter have contributed somewhat to the question of the absorption of dark-heat rays by gases and vapors. Since the first investigations of Tyndall, who maintained that aqueous vapor exerted a powerful absorbing influence upon rays of heat, the tendency has been to diminish the estimated amount of this absorption. Thus, for instance, the results of the observations by Violle on Mont Blanc give 16 per cent. as the sum total by air and moisture combined when a beam of sunlight passes through 2,428 meters of air of uniform temperature and pressure, or an absorption of 0.007 of 1 per cent. for a thickness of one meter of air. But Tyndall's measure gave for pure dry air a greater absorption than this, so that nothing could be left to be attributed to the action of aqueous vapor. If, however, we assume that pure air has no absorption, and that all that was observed in the atmosphere is the result of aqueous vapor alone, even then the figure given by Tyndall—namely, from 4 to 6 per cent. for a thickness of something more than one meter—must be considered as extraordinarily great. The experiments of Tyndall were made with heat rays of a temperature of  $270^{\circ}C$ . The researches of Stefan and Jacques show that Tyndall's figures must be multiplied by one-sixth in order to make them applicable to radiation from the sun, for one meter of atmosphere should absorb 0.102 of 1 per cent. of the heat rays studied by Tyndall, instead of the 4 or 6 per cent. actually observed by him. The explanation of this great difference as now usually accepted is that first given by Magnus—namely, that condensing vapor adhered to the sides of the apparatus. The investigations of Lecher and Pernter entirely agree with this explanation and seem to establish the fact that aqueous vapor proper has no more

effect in absorbing rays of heat than has pure dry air. (*Z. O. G. M.*, Vol. XVI, 1881, p. 37.)

The question of the absorption of the solar heat by atmospheric aqueous vapor has been further supplemented by the studies of Lecher into the absorption of carbonic-acid gas; he finds that a column 1.05<sup>m</sup> long at ordinary pressures and temperatures absorbs 13 per cent. of the heat that reaches the earth's surface when the sun is at its maximum height. (For Vienna this is about 70° above the sun's horizon.) This absorption of the solar rays diminishes very rapidly as the sun sinks toward the horizon, whence it follows that the CO<sub>2</sub> in the atmosphere itself absorbs the radiation in proportion to the length of the path of the ray, and that the total CO<sub>2</sub> in the atmosphere (which is equivalent to a layer 2.4<sup>m</sup> thick at ordinary pressures and temperatures), is sufficient to explain the whole absorption of solar heat, which is about 26 per cent. as shown by Pouillet, or 40 per cent. according to Forbes. (*Z. O. G. M.*, XVI, 1881, p. 271.)

#### V.—SOLAR RADIATION AND TERRESTRIAL TEMPERATURE.

In some remarks on the theory of the general atmospheric circulation Hann says the area of the earth's surface between the equator and 30° latitude is as great as the entire remaining portion of the hemisphere up to the pole (2,308 thousand square miles against 2,323 thousand). The surface of the zone between the tropics and the 45th parallel is still considerably greater than that of the entire area from 45° to the pole (1,427 thousand square miles against 1,364 thousand). The area of the zone from 30 to 40 degrees alone is greater than the entire circumpolar region from the pole to 60° latitude (661 thousand square miles against 625 thousand). That is to say, that when, for instance, the region from 30° to the equator receives in one year an excess of heat of several degrees, this will bring about the outflow overhead of a mass of air that is sufficient to uniformly cover the region from 30° to the pole.

If the air in the zone from the tropics to the 45th parallel is abnormally warmed, then this can have an influence upon the temperature and the weather of the entire portion of the hemisphere lying north thereof up to the Pole, for the upper currents have only this way to flow off, because the gradient in the upper regions prescribes this path. If, therefore, we observe an uncommonly high barometric pressure over Europe and the contiguous portions of the Atlantic Ocean for a long time continuously, then the cause thereof is probably to be found in a previous excess of heat communicated in lower latitudes far beyond the limits of the synoptic chart. Observations of atmospheric pressure at high altitudes of the subtropic and tropical zones will probably give us important conclusions as to the cause of the variable intensity of the upper currents. It is just as important to know the distribution of atmospheric pressure in the upper regions of the air as to know the distribution on the surface of

the earth; indeed still more important, since the latter is generally conditioned upon the former. My present object will be attained if it gives occasion to the more careful study of the changes in the weather and the anomalies in our zone as compared with the temperature conditions of the lower latitudes. (*Z. O. G. M.*, XIV., 1879, p. 40.)

The total intensity of daylight has been investigated by Stelling, who has applied Roscoe's photo-chemical method of observation, depending on the law that the darkening upon chloride of silver paper is in proportion to the product of the intensity of the light and the duration of the exposure. We take the following abstract from a review of his work by Pernter. Stelling's method of determining a scale for measuring the amount of the discoloration consisted in simply exposing various pieces of prepared paper to the influence of the action of daylight during periods of time whose duration was very accurately determined.

The comparison of his own results with those of Bunsen and Roscoe was accomplished by means of a sheet of normal black that Stelling received from Roscoe himself. The coincidence of the normal black with the scale adopted by Stelling was at the point 158, and this point was determined weekly during the entire series of observations in order to allow for any change that might take place in the position of the normal point. In this work freshly prepared slips of paper were always employed, in view of the fact that Roscoe had shown that in nearly all cases an irregular bleaching of the prepared papers took place during six or eight weeks, but that after this time the black tint remained unchanged for many months. Stelling finds that the dryness and the age have little influence, but the method of silvering is important, and that the silvering must be done immediately after the filtration. Stelling's practical application of his results to meteorology relate especially to the question, "What influence has the cloudiness upon the total intensity of daylight?" To this end he first determines the intensity upon clear days, or those on which the cloudiness does not exceed 5 per cent. The observed normal intensity is indicated by the following table of observations at St. Petersburg:

1874.	Intensity.	1875.	Intensity.
November 3 .....	0.041	March 16 .....	0.160
November 18 .....	0.038	April 4 .....	0.201
December 31 .....	0.027	May 2 .....	0.264
		May 19 .....	0.359
1875.		June 1 .....	0.446
January 24 .....	0.038	June 21 .....	0.352
February 13 .....	0.082	July 16 .....	0.306
March 5 .....	0.113	July 29 .....	0.257

The condition of the sky is divided by him into three portions, namely: first, as partially cloudy; second, sufficiently cloudy to hide the sun; third, completely covered, uniform gray sky.

In the first condition, for a cloudiness of from .1 to .7, Stelling concludes that such partial cloudiness exercises no perceptible influence upon the intensity. For the second condition, the sky .9 cloudy or less, he finds that the obscuration of the sun always brings a lowering of the intensity, which on the average amounts to 30 per cent.

For the third condition, the heavens completely covered with the uniform gray tint, he finds that this condition lowers the intensity of the sunlight, on the average, to less than one-half. In general, all these measures of the effect of cloudiness depend on an unknown factor, namely, the thickness and density of the clouds themselves. In general, the minima occur when fog or rain is associated with the horizontal stratus clouds.

The following table shows the monthly maxima and minima:

Monthly maxima.			Monthly minima.		
Date.	Observed intensity.	Normal intensity.	Date.	Observed intensity.	Normal intensity.
Nov. 28, 1874	0.003	0.035	Nov. 2, 1874	0.072	0.040
Dec. 3, 1874	0.007	0.033	Dec. 15, 1874	0.084	0.030
Jan. 5, 1875	0.011	0.029	Jan. 31, 1875	0.080	0.090
Feb. 2, 1875	0.018	0.060	Feb. 28, 1875	0.138	0.102
Mar. 28, 1875	0.056	0.182	Mar. 19, 1875	0.189	0.160
Apr. 13, 1875	0.065	0.220	Apr. 28, 1875	0.254	0.153
May 28, 1875	0.044	0.390	May 22, 1875	0.427	0.355
June 15, 1875	0.042	0.375	June 1, 1875	0.446	0.412
July 30, 1875	0.049	0.260	July 24, 1875	0.315	0.275

This table of maxima shows that only in two months did the maximum occur on days with perfectly clear sky; in all other cases the sky was more or less cloudy and in December completely covered. In the cloudy season Stelling frequently observed similar cases in which high intensities occurred during cloudy weather, a phenomenon which still awaits future explanation. The following table shows the mean intensity of the light for each month at St. Petersburg, so far as the observations extend:

1874.	Monthly mean.	1875.	Monthly mean.
November .....	0.035	March .....	0.120
December .....	0.017	April .....	0.163
1875.		May .....	0.277
January . ....	0.027	June .....	0.292
February .....	0.064	July .....	0.227

It is evident that the photochemical and the photometric methods must be combined with the thermometric in order to attain a complete determination of the absorption in the earth's atmosphere. (*Z. O. G. M.*, 1879, XIV, p. 48.)

The memoir of Wiener on the distribution of the solar radiation over the earth's surface, which was published by him in 1876 in Carlsruhe,



has been republished, with some modifications, in the *Zeitschrift* of the Austrian Meteorological Society. In some respects the author has carried his computations further than was done by Meech in his well-known essay on the relative intensity of the heat and light of the sun.

The following table gives the ratio of  $\frac{i}{I}$ , or the relative intensity of solar radiation at the outer surface of the atmosphere for the entire year.

Latitude.	Relative intensity.	Latitude.	Relative intensity.
0 .....	0.30532	50 .....	0.20876
10 .....	.30112	60 .....	.17368
20 .....	.28858	70 .....	.14464
30 .....	.26832	80 .....	.13096
40 .....	.24122	90 .....	.12672

The relative intensity of the solar radiation is the same for corresponding seasons in the north and south hemisphere; it is a maximum for the whole year at the equator and a minimum at the pole; it is a maximum for the summer season at latitude  $+24^\circ$ ; it is a maximum in the spring and autumn at the equator; during the summer season it is greater at the poles than at any other point on the earth's surface. (*Z. O. G. M.*, XIV, 1879, pp. 113 to 130.)

Wild has published a general review of our knowledge of the subject of earth temperature in connection with his publication of the observations at St. Petersburg and Nukuss. He detects some of the errors and fallacies that have hitherto been persistently diffused in the textbooks on meteorology and physical geography. The observations of earth temperatures made at Nukuss by Dohrandt were for depths of 4.0, 2.8, 1.6, 0.8, 0.4 meters, and the readings were made daily at 7 a. m., 1 and 9 p. m. Besides these a series of hourly readings was made at depths 0.00, 0.05, 0.10, and 0.20 meters under the surface of the earth. This latter series is the only complete one that we possess at the present time for the determination of the diurnal period in the temperature of the earth.

Observations of the temperature of the air were taken at the same time. With regard to the daily period at Nukuss, it is found that the mean daily maximum of earth temperature at the surface is nearly always equal to that of the atmosphere; but the maxima are much greater in the earth than in the atmosphere, so that the daily amplitude is  $2\frac{1}{2}$  times greater at the earth's surface than in the air. During the three summer months the mean temperature of the earth's surface was  $55^\circ.2$  C. The time of occurrence of the minimum of the surface temperature coincides nearly always with sunrise. Warm and dry soil is a worse conductor of heat than the cold damp soil. The influence of temperature and humidity upon the conducting power of the earth was shown in several ways, and is one of the remarkable results attained by

Professor Wild. He also shows that both observations and theory concur in proving that the ordinary law

$$\log \Delta p = A - B \times p$$

(where  $\Delta p$  expresses amplitude of any periodical oscillation at the depth  $p$  under the surface and  $A$  and  $B$  are two constants) has no application to the upper surface of the earth or to the daily oscillations, but is an approximate altitude formula only for greater depths. He gives the most accurate combinations of hours for observations of temperature at the earth's surface and the corrections for the ordinary hours of observation, 7 a. m. and 2 and 9 p. m. After a thorough discussion of the observations made elsewhere through the globe, Wild shows the incorrectness of Boussingault's conclusion that in the neighborhood of the Equator, under a protecting roof, the annual and the daily variations in temperature within the earth disappear at a depth of less than 0.5 meter.

Even with an annual change in temperature of only  $1^{\circ}.5$  C, and with the largest value of  $B$  at Nukuss, the depth  $p$  at which the oscillation of temperature is only 0.1 of a degree is about five meters; at Trevandrum the depth is 9.6 meters.

In general we may say that the stratum of earth whose temperature sensibly varies in the course of the year is in various places rarely less than 6 meters and rarely greater than 33 meters. In general, Wild concludes that the condition of the outer surface of the earth with respect to temperature can be well presented by means of the well-known sine formula of Bessel. If, now, the periodical changes in the temperature at the surface penetrate to the lower depths, then, according to the theory of Poisson, there should be a gradual diminution in the amplitude and change of phase of the movement of all the periodical terms; but the attempt to represent observations by the strict theory of Poisson is so unsatisfactory as to render the theory but of little use when it is applied to changes of short period, such as a day or a year, while the longer periods such as 13 or 18 years are fairly represented.

The second thermal constant of the earth, namely, its conductivity, can at present not be satisfactorily determined, but the constant ratio between conductivity and capacity for heat is determined with considerable accuracy. (*Z. O. G. M.*, XIV, p. 272.)

Pernter gives a comparison of the methods of measuring the chemical intensity of the light. These methods, so far as they have yet been proposed, are as follows:

*First.* Bunsen and Roscoe's chlorine and hydrogen photometer.

*Second.* Bunsen and Roscoe's photographic actinometer, which measures the chemical intensity by the blackening of chloride of silver paper.

*Third.* Marchand's photantitypimeter. (This awkward name is given by Marchand himself, based on the Greek *αντιτυπια*.) The principle of his apparatus consists in the determination of the quantity of carbonic acid eliminated from a mixture of chloride of iron and oxalic acid exposed to the influence of light.

*Fourth.* Vogel's chemical photometer. This was especially designed for the use of the photographer, and requires considerable further study before it can be used for accurate scientific purposes. The measurements are based essentially upon the action of light upon sensitive chrome paper.

*Fifth.* Draper's tithonometer. This was the first attempt to measure the chemical intensity of light, and its principle is similar to that of Bunsen and Roscoe's chlorhydrogen, but it could not yield accurate results.

*Sixth.* Becquerel's electro-chemical actinometer. This consists of a jar of water, in which two silver plates are immersed, which are covered with equally thick layers of violet silver chloride. A conducting wire connects them, and a delicate electric galvanometer is introduced into the current. If these plates are exposed to the light the needle of the galvanometer shows the existence of an electric current. After a careful discussion of the relative merits of these methods Pernter shows that the total chemical intensity can, in no case, be measured absolutely, so long as the apparatus takes account of only one portion of the spectrum, since it is now known that all the rays of the spectrum have chemical effects, provided they fall upon the proper substances. Keeping this in view, as well as on account of its convenience, Pernter maintains that the photographic actinometer is the least objectionable instrument, and has, in fact, a great advantage over the others, in that no absorbing glass or other substance intervenes between the source of light and the sensitive paper. He earnestly recommends, therefore, that for future observations in meteorology, when the object is to determine the relative intensity of the sunlight at given moments, the photographic actinometer be employed, as the chemical preparations are easy to make, the manipulations are soon acquired, the observations require but a very short time, and the apparatus is so portable as to be available on scientific expeditions. On the other hand, if the object is to determine the sum total of the action of sunlight during the day or other interval, then the photantitypimeter of Marchand has the advantage, in case the preparation of chloride of iron is intrusted to skillful hands. (*Z. O. G. M.*, XIV, p. 254.)

Having given this general review of the methods adopted by investigators, Pernter details the results attained hitherto in the photo-chemical measurement of sunlight. Bunsen and Roscoe, with their chlorhydrogen photometer, found that the chemical intensity of diffuse daylight (H) is represented by the following formula :

$$H = 2.776 + 80.849 \cos \varphi - 45.996 \cos^2 \varphi$$

But for the chemical intensity (J) of the direct sunlight falling perpendicularly upon the sensitive plate, they found an exponential formula which, multiplied by  $\cos \varphi$ , gives the intensity (S) upon a horizontal area at the surface of the earth, and which is approximately as follows:

$$S = 31.99 \cos^2 \varphi + 417.6 \cos^3 \varphi - 248.7 \cos^4 \varphi$$

In this formula  $\varphi$  is the zenith distance of the sun, and the constants themselves refer to a unit of light, of which each corresponds to the development of 0.111 units of hydrochloric acid per minute per square centimeter.

The sum total  $H + S$  represents the chemical intensity of all the daylight which falls upon a horizontal element of the earth's surface, and this, according to Radan, can be fairly well represented by the formula:

$$H + S = 3.1 + 0.635 \times h + 0.05775 h^2 - 0.00048 h^3$$

where  $h$  represents the altitude of the sun, or  $90^\circ - \varphi$ . These results of Bunsen and Roscoe may be compared with measures made by means of photantitypimeter of Marchand, which instrument is especially designed to give the normal changes of the chemical intensity of the total daylight. Unfortunately the observations made by Marchand at Fécamp, on the coast of France,  $49^\circ 45'$  north latitude, suffered from the frequency of cloud and haze. But they show that the maximum at Fécamp occurred decidedly after midday, and that between 10 a. m. and noon the chemical intensity experienced a decided diminution, while the symmetry of the morning and afternoon observations is such that the chemical intensity is decidedly greater in the afternoon than the morning. In all these respects, therefore, Marchand's results are opposed to those given by Bunsen and Roscoe. But the differences may be due, among other things, to the local peculiarities of stations. If now we compare Bunsen and Roscoe's results with those obtained by means of the photographic actinometer, we find (1) that the latter show the normal chemical intensity of total daylight to be a function of the altitude of the sun, and represented by the equation  $J_h = J_0 + ah$ . (2) The maximum occurs at midday and the same intensity prevails for the same altitude before and after noon. (3) The constants in the equation just given change for every locality and for the same locality every day. These constants are functions of atmospheric moisture and whatever affects the clearness of the air.

These are now to be compared with those deduced from observations made by Roscoe and Thorpe, in August, 1865, near Lisbon, Portugal. During fifteen days of normal clearness their observations show that the normal intensity at Lisbon during the course of the day can be fairly represented by an equation whose form is  $J_h = J_0 + ah$ , but the afternoon shows a sensible diminution of the chemical intensity at about 2 p. m.; were it not for this break at 2 p. m. it would be of the same form as for the morning, having, however, very different constants.

Observations were also made by Roscoe, in December, 1870, at Catania in Spain, but embraced only three complete days. From these it results that the maximum of chemical intensity occurs at about 11 a. m.

At noon and during the afternoon notable diminutions of the chemical intensities occur; so for equal solar altitudes the intensity before noon is greater than in the afternoon.

From all these observations it follows that the diurnal change in chemical intensity is as complicated a function of the solar altitude as is the change in atmospheric moisture, transparency, &c.

It is almost certain that the intensity is directly and principally dependent upon the variation of the hygrometric condition.

Knowing the normal daily curve of chemical intensity we easily compute the annual curve, and the variation with latitude. In this respect Pernter compares the observations of Bunsen and Roscoe, Marchand, who observed daily for four years, and those at Kew and Greenwich, and Southern Europe, and finally Pará, in Brazil. The following table gives a series of relative numbers as observed by Marchand:

Months	1869.	1870.	1871.	1872.	Mean.
January.....	1.17	2.37	1.71	2.11	1.84
February.....	2.25	3.88	4.19	5.52	3.98
March.....	1.67	4.21	10.10	9.76	6.44
April.....	7.82	19.01	14.19	15.36	14.09
May.....	12.27	20.90	21.42	17.85	18.11
June.....	21.51	22.33	17.05	23.27	21.04
July.....	21.43	19.42	21.67	23.23	21.49
August.....	17.75	19.83	20.74	17.41	18.93
September.....	18.82	16.82	11.75	12.21	13.60
October.....	6.46	7.83	6.29	17.19	6.90
November.....	2.35	3.35	3.12	2.78	2.90
December.....	1.69	1.70	1.58	1.99	1.74
Annual mean.....	9.19	11.79	11.15	11.56	10.92

We now come to the question of the ratio of the intensities of the diffuse daylight and the direct sunlight. The results of observation by Bunsen and Roscoe on the separate values of these intensities are expressed in the equations for H and S above given, and according to which the following table is computed:

Altitude.	H.	S.
0	8.1	0.0
10	15.1	0.5
20	27.7	9.5
30	31.7	30.1
40	36.1	56.0
50	38.1	82.2
60	39.1	105.4
70	39.6	123.3
80	39.7	134.6
90	39.7	138.4

From this table we see in a striking manner that up to an altitude of 10° the chemical intensity of direct sunlight is inappreciable, a result that is abundantly confirmed by more recent observations, and yet direct photometric measures of the ratio between the intensities H and

show that even at zero degrees altitude the optical intensity of direct sunlight is much greater than the optical intensity of diffuse light. It does not follow from this that the chemical intensities have no relation to the optical, for the chemically active rays are almost entirely absorbed in the atmosphere when the sun is low; and we must conclude that the optical and chemical intensities of the sunlight vary differently with the solar altitude. Again, this table shows us that up to a considerable altitude, say  $31^{\circ}$ , the chemical intensity of diffuse daylight is greater than that of direct sunlight. This result is confirmed by the observations of the photographic actinometer. We here perceive another beneficial influence of our atmosphere similar to that experienced in the case of heat and light.

In northern regions where the altitude of the sun never exceeds about  $30^{\circ}$ , the chemical intensity of the direct sunlight will have too feeble an effect; and the effect of diffused light compensates for this. Thus at St. Petersburg at the time of equinoxes the chemical intensity of diffuse daylight is twice as great as that of direct sunlight, and at Melville Island it is ten times as great.

The preceding data give us the means of computing approximately the total amount of absorption that must take place in the atmosphere of the earth, and it results that an intensity of 35.3 units at the outer surface of the atmosphere becomes 20.0 at the earth's surface. This immense absorption is surprising and is unequally divided between the various portions of the spectrum. The chemical end loses about one-third; and the warm rays of the spectrum lose about three-fourths of their original intensity.

The influence of the cloudiness is in every respect the most disturbing. This has been studied by Stelling, who concludes that the influence of a partial cloudiness is now to raise and then to lower the absorption. Second, the influence of partial cloudiness, if the sun is behind clouds, is almost always without exception a depression, and on the average about 30 per cent. Third, the influence of a completely covered uniform gray sky is still more depressing; it lowers the normal intensity on the average by more than one-half. (*Z. O. G. M.*, XIV, pp. 401 to 426.)

In an essay on the ripening of fruits, Levy investigates the manner in which the insolation affects the development of the plants. It is evident that we must not only from agricultural reasons, but also in the general interest of the science in the future, lay more stress on the insolation observations; but whether the Arago-Davy instrument is to be adopted as sufficiently safe cannot be decided here. It must be decided first of all what rays of the solar spectrum produce these chemical effects, and in case these are not the brightest, then this actinometer does not measure the heat they send; but it does serve excellently as a photo-chemical method. (*Z. O. G. M.*, Vol. XV, 1880, p. 30.)

Whipple has discussed the measurements of relative durations of sun-

shine as recorded by means of the Campbell sunshine recorder at Greenwich and Kew. Inasmuch as Kew is west while Greenwich is south-east of the principal portion of London, the records show especially the local influence of the smoke and dust of the city. Thus the mean daily duration of sunshine for each direction of the wind is shown by the following table:

Wind.	Greenwich.	Kew.
N.....	2.5	2.5
NE.....	2.9	2.3
E.....	5.7	4.6
SE.....	3.6	2.3
S.....	2.6	2.8
SW.....	3.8	4.1
W.....	3.8	4.8
NW.....	2.0	3.9
Variable....	3.0	3.0

(*Z. O. G. M.*, XV, 1880, p. 101.)

Roth, in a study upon the distribution of solar radiation and the possibility of a difference in the temperature of the northern and southern hemispheres in consequence of the position of the earth in space, has from the elements of the planetary systems deduced the absolute values of the quantities of heat received by the whole planetary sphere or by a given portion of surface, while the planet moves about the sun according to Kepler's laws. The angle of incidence from the sun remaining invariable while the radius of the orbit describes a certain angle. Let  $W$  be the quantity of heat;  $S$  the quantity of heat which the same surface would receive in the same time from the sun at the unit's distance;  $A$  the attractive force of the sun at the unit's distance;  $p$  the perimeter of the orbit;  $\varphi_0$  and  $\varphi_1$ , the first and last value of the true anomaly; then we have

$$W = \frac{3(\varphi_0 - \varphi_1)}{\sqrt{A} p}$$

(*Z. O. G. M.*, Vol. XV, 1880, p. 322.)

Supan has sought to introduce a new distribution of the earth's surface according to the relative temperatures. In order to define these temperatures with all definiteness, he seeks a new construction of the isotherms based on the temperature determinations at present available. His new annual isotherms are a valuable contribution. (*Z. O. G. M.*, Vol. XV, 1880, p. 324.)

Prof. O. Martins, of Montpellier, who was appointed director of the botanical gardens of that place in 1851, immediately began a new series of meteorological observations in continuation of those that have been made there ever since 1705. The botanical garden is about 8<sup>k</sup> from the ocean, and about 58<sup>m</sup> above the sea, in latitude 43° 37'. The following table gives the temperature of the air as observed at an altitude of 1½<sup>m</sup>

above the soil, and 29<sup>m</sup> above the sea, and also the temperature of the spring water:

Month.	Mean temperature of air.	Mean temperature of spring water.
	<i>Degrees C.</i>	<i>Degrees C.</i>
December .....	5.0	12.8
January .....	4.9	11.5
February .....	5.9	11.2
March .....	8.8	11.4
April .....	13.1	11.8
May .....	16.7	12.12
June .....	20.3	12.8
July .....	23.0	18.7
August .....	22.0	14.0
September .....	18.8	14.0
October .....	14.1	13.1
November .....	8.5	13.5
Annual .....	13.4	12.8

For the temperature of the earth we must refer to the original memoir published by the Academy of Sciences, Montpellier, Vol. IX. In winter and spring the plateaus of the Avennes, which rise to an altitude of 2,500 feet, are covered with snow, and the northwest mistral precipitates itself with great force from these down upon the warm lowlands to the southward. At this time the atmosphere at Montpellier is very dry, and of wonderful clearness. This favors the radiation at night, and the insolation by daytime thereby increasing the magnitude of the daily variations of temperature. The mistral occurs most frequently in the spring-time, and these beautiful days are known as the "cavalier." In the summer-time the plateaus are greatly warmed up, and the mistral loses its force and frequency. In the autumn the temperature is most uniform, and the mistral least frequent. The intensity of the mistral has a well-marked diurnal period; it increases as the sun approaches the meridian in proportion as the sea-shore is warmed up. It ceases during the night-time to begin again about 9 a. m. (*Z. O. G. M.*, Vol. XV, 1860, p. 455.)

Mahlen has studied the observations of temperature of 118 years at St. Petersburg, being nearly the whole of the interval 1743 to 1878. Among his results we find the following: The coldest day of the normal year was January 24; temperature,  $-9.7^{\circ}$ ; the warmest day was July 23,  $+70.9^{\circ}$ ; the mean temperature of the year is  $+3.72^{\circ}$ , which is the same as the mean temperature of April 23 and October 21. The variability of the daily temperature is such that in winter 2,300 years, but in August 380 years, of observation would be required to obtain daily means, whose probable error is  $\pm 0.1^{\circ}$  C. The mean departure of daily means from the annual average is greatest for January 20 ( $6.23^{\circ}$  C); the least is for August 28 ( $2.13^{\circ}$  C). The greatest absolute variation for any one day is from  $+5.2^{\circ}$  on January 4, 1771, to  $-37.4^{\circ}$  January 4, 1814. The coldest January occurred in 1814, and the warmest in 1866. The coldest July occurred in 1878, and the warmest in 1757. The coldest



year ( $1.15^{\circ}$ ) was 1819; the warmest ( $6.25^{\circ}$ ) was 1826. (*Z. O. G. M.*, XVI, 1881, p. 492.)

Dr. F. M. Stapff, geologist of the St. Gothard railroad, has discussed the observations of the temperature of the earth made by Forman in the Comstock lode, Nevada. He finds that below 1,600 feet the rate of increase of temperature begins to diminish, and that, as we cannot safely extrapolate, therefore no conclusion can be drawn as to temperatures at greater depths in the earth than about 2,000 feet. As the result of year, of experience in measuring temperatures of stone, Stapff estimates that it would be impossible by direct observation to decide the question whether or no temperatures increase in the interior of the earth.

The delicacy of the temperature changes, the unavoidable disturbances from the drill, and the irregularities due to streams of water are only to be overcome by persistent study of the various sources of error.

In the second communication Stapff gives a new formula, and shows that the computed temperatures of the air at the surface, as observed for twelve years, agrees with that computed from the observed temperatures within the mines. (*Z. O. G. M.*, XVI, 1881, pp. 414 and 518.)

Buys Ballot has published (*Archives Neulandaises*, Tome XV) an exhaustive memoir on the annual periodicity and variability of temperature of Europe. By combining three days into one triad and three such triads into a series of nine days' means, he studies the perturbations in the regular annual temperature curves. By subtracting the means of two triads ten days apart and dividing by 10 he obtains the average rate of change of temperature for all portions of the year, and the average of these ten-day changes at seventeen places, for which long series of observations are available, gives him an expression for the normal average periodicity of temperature in Europe, independent of local disturbances, which latter can then be determined. In reference to the variability of temperature, Buys Ballot attempts to properly represent, first, the daily variation; second, the uncertainty of the temperature of any day of the month or year; third, the magnitude of inequalities of long periods. Very interesting are his tables showing the tendency of the weather to repeat itself in successive months; thus, if the tendency to repetition is a mere matter of chance, then the chance that out of 374 months six successive months should have the same character, namely, warmer or colder, then the average would be  $\frac{1}{374}$ , as given in the second column of the following table, whereas the observed number of such months is 36, as given in the third column:

Successive months.	Probability.	Observed.
2	187	211
3	*94	128
4	47	81
5	23	52
6	12	36
7	6	25
8	3	17

Successive months.	Probability.	Observed.
9	2	.11
10	1	9
11	0	7
12	0	5
13	0	3
14	0	2
15	0	1

(Z. O. G. M., XVI, 1881, p. 404.)

A. Müttrich has published and discussed the observations of earth temperatures at the Prussian forest stations. The bi-hourly observations for fourteen days at the central station give a means of reducing regular observations at 8 a. m., 1 and 2 p. m. to normal means. The following table shows the temperatures in the open fields and in shady forests in (C.) degrees:

Location.	Fields.			Forests.		
	Min.	Max.	Range.	Min.	Max.	Range.
Air.....	° C. 12.40	° C. 22.68	° C. 10.28	° C. 13.00	° C. 21.80	° C. 8.80
Depth, 0.02" ....	15.08	22.60	11.52	14.28	20.90	6.62
Depth, 0.15" ....	17.20	22.98	5.78	14.90	17.43	2.53
Depth, 0.30" ....	16.55	18.15	1.60	14.78	15.61	0.83
Depth, 0.60" ....	15.75	15.92	1.17	13.15	13.22	0.07

(Z. O. G. M., XVI, 1881, p. 268.)

Wild has completed the great work on temperature in Russia, of which the first volume in 1878. He has corrected and discussed all important temperature records relating to the Russian Empire, and the magnificent charts showing monthly isotherms and isoabnormals for Europe and Asia make a profound impression upon the reader. In the construction of these charts the various series are reduced to a nearly uniform series of normal years. Reductions to sea-level are also introduced, based upon the following table, which is derived especially from observations in the Caucasus:

*Rate of temperature diminution for each 100 meters of ascent.*

Month.	Rate.	Month.	Rate.
December .....	0.25 C.	July .....	0.59 C.
January .....	0.36	August.....	0.60
February.....	0.43	September.....	0.53
March.....	0.48	October .....	0.46
April.....	0.56	November .....	0.21
May .....	0.58	Year .....	0.47
June .....	0.61		

(Z. O. G. M., XVI, p. 217.)

Dr. Augustin has published an elaborate study upon the self-recorded temperatures at Prague during the interval 1840 to 1877. The following extract shows the direct influence of insolation and of cloudiness:

Month.	846 wholly clear days.				2,279 cloudy days.			
	Mean temperature.	Daily amplitude.	Epoch of minimum.	Epoch of maximum.	Mean temperature.	Daily amplitude.	Epoch of minimum.	Epoch of maximum.
Dec.....	° - 5.7	° 5.2	A. M. 7 10 a. m.	A. M. 2 30 p. m.	° + 0.3	° 1.2	A. M. 7 0 a. m.	A. M. 2 0 p. m.
Jan.....	- 8.5	5.6	7 20	2 40	- 1.1	1.4	6 30	2 0
Feb.....	- 5.4	7.2	7 20	2 50	+ 0.6	2.3	6 5	2 15
Mar.....	+ 2.7	9.5	6 10	2 57	3.2	3.0	6 5	2 15
Apr.....	9.4	12.5	6 0	3 15	7.5	4.0	5 50	2 20
May.....	15.8	12.3	5 50	3 9	11.9	4.1	5 40	2 40
June.....	19.6	11.5	5 0	3 15	15.0	4.0	4 40	2 30
July.....	22.0	11.9	5 30	3 35	16.5	4.4	4 50	2 50
Aug.....	21.5	12.2	5 50	3 20	16.9	3.7	5 40	2 40
Sept.....	16.6	12.0	6 10	3 5	13.2	3.7	6 0	2 30
Oct.....	9.2	10.8	6 25	2 40	8.9	3.1	5 50	2 10
Nov.....	0.0	5.9	7 10	2 30	3.5	1.9	6 23	2 30
Year.....	8.1	9.5	6 25	2 59	8.0	3.1	5 53	2 23

(Z. O. G. M., XVI, 1881, p. 168.)

O. Jesse, of Steglitz, has investigated the diurnal variations of temperature on clear days at Hamburg. His results are based upon the records of the self-registering thermometer for three years at the Deutsch Seewarte. He selected only very clear days and those on which the temperature at the end of a twenty-four hour period agreed within one degree centigrade of that of the beginning, hoping thereby to deduce a simple relation between temperature and the altitude of the sun. The months October, November, and December were too cloudy to afford any proper data. His resulting equation gives the departure ( $w$ ) for any hour ( $x$ ) from the mean temperature of any day of the year on which the sun's altitude above the horizon at noon is  $h$ , and it reads as follows:

$$\begin{aligned} \Delta w = & (5^{\circ}.4 \sin h) \sin X - (1^{\circ}.83) \cos X. \\ & + (0^{\circ}.70 \sin h - 0.49 \cos h) \sin 2X. \\ & + (1^{\circ}.28 \sin h - 1.61 \cos h) \cos 2X. \end{aligned}$$

The departure of the computed from the observed values shows traces of periodicity that are as yet unexplained. (Z. O. G. M., 1881, XVI, p. 96.)

Billwiller, of Zurich, has studied the vertical distribution of temperature in the atmosphere within areas of high barometer and relatively clear weather. He shows that the so-called anomaly, by reason of which the air sometimes grows warmer as we ascend, or, more properly, the layers of cold air lie quietly below the warm air, is due to terrestrial radiation, and is a characteristic of areas of high pressure; also, that this condition occurs in summer as well as winter, and tends to maintain the permanence of "high areas" in proportion to the increasing length of the night-time relative to the day-time; also, that the areas

of barometric maxima are reinforced when over the land as compared with the sea. He traces the nightly flow of cool air down mountain slopes and its accumulation in valleys, its warming by compression and by formation of dew, its cooling by radiation, and its contraction by cooling, and deduces the resulting influence of all this upon the diurnal fluctuations of barometric pressure. (*Z. O. G. M.*, Vol. XVI, 1881, p. 94.)

Supan, in an extensive memoir on the annual variations of heat on the earth's surface, says: In general the annual variation increases from the equator towards the poles, and from the coast line towards the interior. If we determine the mean annual variability for the different latitudes, we find the following values:

Latitude.	Annual variability.
70° N.	35.6
60° N.	31.1
50 N.	25.4
40' N.	19.2
30 N.	12.4
20 N.	8.4
1.0	3.7
.0	1.3
10° S.	2.9
20° S.	6.0
30°	8.1
40°	8.8

(*Z. O. G. M.*, Vol. XVI, 1881, p. 38.)

Pernter has studied the distribution of sunshine as recorded since April, 1880, by means of the sunshine-recorder invented by Campbell, and consisting of a glass lens, by means of which the concentrated sun's rays fall upon and burn into a paper strip. On account of the importance of a better knowledge of the duration of sunshine, it is to be hoped that similar cheap and simple registers shall be kept at numerous stations throughout the world. The following table shows the diurnal variability:

Months.	Morning.	Afternoon.	Daily mean.
April .....	2.14	2.74	4.88
May .....	2.41	2.51	4.92
June .....	3.69	3.75	7.41
July .....	5.29	5.11	10.40
Aug .....	8.53	8.64	7.17
Sept .....	2.88	3.16	6.04

(*Z. O. G. M.*, Vol. XVI, 1881, p. 9.)

#### VI.—MOISTURE, CLOUDS, RAIN, ETC.

The connection between rainfalls and solar spots has been further elucidated by Meldrum, who has computed new values of the averages in order to meet the objections that have been raised against this pre-

vious work. The following table gives his figures for the rainfall at Madras. The first column gives the year of the solar-spot cycle. The second column gives Wolf's relative numbers for the spots averaged for the same years as the rainfall. The third column gives the mean observed rainfall for several corresponding years of sun-spot cycles. The fourth column gives the same means, after combining three of these values in one, in order to diminish the irregularities:

Year of solar spot cycle.	Wolf's relative numbers.	Rainfall. Madras, 1811 to 1877.
1	-----	35.3 -----
2	— 34	51.4 45.3
3	— 23	42.4 48.3
4	0	55.8 51.3
5	+ 28	51.2 51.2
6	+ 43	47.8 48.2
7	+ 34	46.9 48.7
8	+ 17	53.7 50.4
9	0	47.8 51.5
10	— 14	58.0 50.7
11	— 24	39.5 45.2
12	— 26	44.6 42.1
13	-----	39.7 -----

There seem to be two maxima and minima in the rainfall at Madras, the minima coinciding with the minima and maxima of the sun spots. The result to which Meldrum has arrived at Madras shows how much depends upon the method according to which the years are grouped. Like Dr. Hunter, he himself had previously found a decided maximum of rainfall at the time of the maximum of spots. Meldrum shows further that in the case of Edinburgh we obtain very different results when we group the years as Dr. Hunter has done—that in fact we obtain a minimum of rainfall in the fifth or maximum year of sun spots.

If in general the rainfall is above the mean in the years of sun-spot maxima, and below the mean in the years of minima, then we must have the following equation:  $\frac{S-s}{s'-S} = \frac{R-r}{r'-R}$ , where large S is the mean value of sun-spot frequency for the whole period under investigation, small s is the mean for the period during which the sun-spot frequency is below the mean; small s' is the value for the period where the sun-spot frequency is above the mean; R, r, r' the corresponding annual rainfalls for those years for which S, s, s' hold good. That the frequency of sun spots has a simple ratio to the rainfall is now evident from the fact that the above equation apparently holds good approximately for fifty-four stations in Great Britain, and thirty-four in America for the interval 1824 to 1867. During this interval the rainfall was in excess when the spots were in excess, and deficient when the spots were deficient. The excess was .90 of an inch in England and 1.13 inches in America; and the deficiencies were .75 inches in England and .94 in America. (*Z. O. G. M.*, 1879, Vol. XIV. p. 22.)

S. A. Hill has published the result of a short discussion as to the

position and physical cause of the existence of a zone of maximum rainfall in the Northwestern Himalayas.

The existence of such a zone was already known to General Strachey in 1849, but with the help of a large number of observations Hill is able to show that the relative quantity of rain ( $R$ ) falling at the high and low stations is very closely represented by the formula

$$R = 1 + 1.92h - 0.40h^2 + 0.02h^3$$

in which  $h$  is the relative altitude of the upper stations above the plain. The differential of this formula gives the equation for the determination of the value of  $h$  corresponding to the maximum relative rainfall, which position is easily found to be  $h = 3,160$  feet relative to the lower stations or 4,160 feet above the sea-level. As regards the cause of this excessive rainfall at a definite and moderate altitude, Hill adopts the explanation suggested by General Strachey. The variation in the tension of vapor ( $p$ ), up to an altitude of 1,200 feet, is closely represented by the formula

$$p = p_0(1 - ah + \beta h^2)$$

in which  $a$  and  $\beta$  are certain constants that must be determined from observations.

Dr. Hann has shown that the tension of vapor can be closely represented by the barometric formula

$$\log p = \log p_0 - \frac{h}{c}$$

where the constant  $c$  has about a value of 6,500. According to each of the formulæ the measure of the diminution of tension of vapor is greater in proportion as the altitude is less. If once the temperature sinks to the dew-point the quotient  $\frac{dp}{dh}$  is a measure of the quantity of the precipitation, and we must therefore expect that the rain is heaviest in that zone where on the average a mass of air ascending from the lower plains reaches the point of saturation with aqueous vapor. This zone can be determined with sufficient accuracy for the region studied by Mr. Hill, if we seek the altitude at which the temperature during the rainy season is equal to that of the dew-point at Roorkee. A computation of this kind is made by Mr. Hill for three months, with the following results:

Month.	Dew-point.	Temperature.	Altitude.
	°	°	Feet.
July .....	75.2	85.2	3,141
August .....	75.7	84.5	2,710
September .....	78.1	83.0	3,099

The mean altitude at which the rainfall may be expected to be greatest lies, according to this theory, about 3,000 feet above the lower plain-

The complete agreement between this result and that computed by the empirical formula above given is a good proof of the accuracy of the latter up to altitudes of ten or eleven thousand feet, and it will be interesting to make a similar study for the Alps and other mountainous countries. (*Z. O. G. M.*, XIV, p. 165.)

Jamin has undertaken to elucidate the formation of dew, and to remove the difficulty experienced by some in acknowledging that it is possible to have a cooling of the leaves of plants down to 8 or 10 degrees below the temperature of the surrounding air. In the formation of dew, radiation and evaporation are the two factors to be considered. For the radiation we have the law of Dulong and Petit, for bodies which are surrounded by air, which is as follows:

$$v = ma^{t+\theta} - ma^{\theta} + np^{ct}.^{233}$$

Since the surrounding inclosure is the celestial space itself, whose power of emission is certainly very near zero, therefore the term  $ma^{\theta}$  is negligible.

In consequence of the radiation of bodies, which is represented by  $ma^{t+\theta}$ , the temperature lowers; the lost heat is replaced by that of the air coming in contact with the surface, as is expressed by the term  $np^{ct}.^{233}$ . The air becomes cooler, falls to the earth, and in consequence of the radiation is continually being cooled still lower. Gradually the lower cold stratum of air abstracts heat from the upper stratum, which is still warm, so that the cooling process takes place from below and upwards.

The above describes the effect of radiation only as it occurs when the sky is perfectly free from clouds; when the heavens are beclouded this constitutes an enveloping surface, that can be considered as being of the same temperature with that of the radiating surface of the earth. In this case the first two terms of the above equation disappear, and a thermometer cannot then indicate anything but the temperature of the air.

The evaporation co-operates with radiation, and is always active on the moist surface of plants; this effect is represented by the same law as that which expresses the action of the psychrometer.

Every moist body, in consequence of evaporation, assumes a lower temperature; the process in general is analogous to that of radiation. The body cools down and absorbs heat from the surrounding air so long as the evaporation continues. But while the process of radiation has almost no limit, the process of evaporation has one which is attained when the surrounding cooled air has reached the limit of saturation; from this point on the cooling through evaporation ceases. Any formation of dew, due to a further cooling, occurs in consequence of the radiation, so that the evaporation contributes thereto only as preparatory, by stimulating the cooling process which the radiation itself brings about; the formation of dew itself then is only a further consequence of

the radiation. As soon as dew begins to form this condensation now acts in a direction contrary to that of the previous evaporation; by this condensation the latent heat of the aqueous vapor is set free, and so delays the further process of cooling through radiation.

This superposition of the two processes can be best investigated if we endeavor to observe them separately. Take three thermometers—the first having a metallic polished spherical bulb, the second a dry blackened spherical bulb, the third a wet or moistened blackened spherical bulb. Then the first thermometer, if it is protected from the heat radiated from the earth, and also protected by a roof, will give simply the temperature of the air, since the radiating power of its own surface can be taken as zero; the second thermometer, if allowed to radiate freely into the sky, will give simply the effect of radiation; the third thermometer, also radiating freely to the sky, will give the total effect of radiation and evaporation together. Such investigations, according to Jamin, show that the cooling due to evaporation is almost always equal to that due to radiation, and sometimes exceeds it; therefore, in the explanation of the forming of dew it is certainly not to be neglected. The following example of observed temperatures, before and after the formation of dew, sets the whole process forth more clearly:

Time.		Temperature of the air.	Differences for three minutes.
<i>h.</i>	<i>m.</i>	<i>Degrees C.</i>	
3	13	11.00	-----
3	16	9.60	1.40
3	19	8.55	1.05
3	22	7.65	0.90
3	25	7.30	*0.35
3	28	7.00	0.30
3	31	6.68	0.32

\* Dew point, 7.05.

(*Z. O. G. M.*, XIV, p. 324.)

In a short article on the climate of central equatorial parts of the Pacific Ocean, Woeikof collects together a few notes relative to observations made on small guano islands near the equator. He especially calls attention to the small rainfall recorded for these islands, and suggests that durable rain gauges be constructed of such pattern that they can be permanently left on such small uninhabited islands, and from time to time be visited in order to keep the record of the rainfall. He expresses the hope that navigators of the Navy or merchant marine may find opportunity to carry out his suggestion. (*Z. O. G. M.*, XV, 1880, p. 120.)

In a note on crystallized forms of hail, Merrian states that among the various views that have been expressed as to the origin of these forms, it seems to him probable that repeated melting and freezing of layers of water plays an important part. We can assume that at first a kernel



is formed from a collection of radiating snow crystals, and that then on falling through a cloud, which is itself constructed of watery vesicles, at a temperature below freezing, the kernel is concentrically covered with ice, which at first is crystallized, and by its further growth assumes its regular crystalline forms. A rotation of the hail storm about any one axis will give it a symmetrical form. (*Z. O. G. M.*, XV, 1880, p. 133.)

Dr. Hildebrandsson has endeavored to introduce further intelligent conformity among the observers of clouds, and to better illustrate the classification adopted by himself at Upsala has published a volume of photographs of clouds in which seven plates are devoted to cirro-stratus and nimbus, and five are devoted to cirro-cumulus and strato-cumulus, and four to the cumulus and cumulo-stratus. The photographs are by Osti. In general Hildebrandsson adheres to Howard's terminology. (*Z. O. G. M.*, Vol. XV, p. 242.)

Hann has investigated the annual period of rainfall in Austria-Hungary, making use of all observations available up to the year 1878. These observations refer to 181 stations, of which 146 furnished series of ten years or more in length. The principal question and most important one to be investigated was, how far the annual distribution of rain at the neighboring stations agreed or differed among themselves. To this end each monthly rainfall was converted into a percentage of the annual rainfall, and the results arranged into thirty-four groups, representing as many localities. Among the generalizations thus brought to light is the fact that on either side of the Donau there exists a decided tendency to a double maximum of the rainfall in June and August respectively, while in other portions of the empire the maximum occurs either in June or October. (*Z. O. G. M.*, Vol. XV, 1880, p. 249.)

Mr. Dines has made some observations in regard to the size of the water particles or drops in dense fogs. The magnitude of these particles is not uniform even in the same fog, but varies between 0.00062 inch and 0.005 inch; but these larger particles are only observed in very dense fog and at a time when the rain itself is falling. (*Z. O. G. M.*, Vol. XV, 1880, p. 375.)

Köppen and Sprung have investigated the distribution of rain over the Atlantic Ocean, as it results from the observations made on the vessels of the German marine during the years 1868 to 1872, and recorded in 178 journals selected from a large mass of records. They state that at all seasons of the year we find on the Atlantic Ocean three large regions especially rich in rainfall, viz, the equatorial and the two extra-tropical, and between these lie two regions of scanty rainfall, which are the two zones of trade winds, but in these latter the deficiency of rain is only a relative quantity, and it is only in special regions, especially in the eastern half of the ocean, that these become regions of no rainfall. In general, even in the trade-wind regions, from 20 to 30 per cent. of the days have showers of rain, and the frequency of the rain is, there-

fore, not less than it is in Southern Europe during the rainiest half of the year, and is, therefore, not at all to be compared with the drought of the great continental deserts. These regions of small and great rainfall vary their position and their extent in the course of the year. During our northern summers the equatorial rainy region and the two adjacent regions of light rainfall have a position ten or fifteen degrees more to the north, and the northern extra-tropical rain-belt has a much smaller extension than during our winter season. The equatorial rain-belt coincides with the belt of calms, and corresponding to this it lies during March between  $4^{\circ}$  north and  $4^{\circ}$  south latitude; but during July it lies between  $6^{\circ}$  north and  $12^{\circ}$  north. The position at which the rain-belt is found at the close of our winter is occupied in midsummer by the belt of least rainfall in the region of southeast trades. The position of the calm-belt in summer is occupied in the beginning of spring by the belt of least rain lying in the region of the northeast trades. The region beyond the northern limits of the Tropic of Capricorn, where rain falls on more than half the days of the year, is confined in the summer time to a small space in the center of the ocean between  $42^{\circ}$  and  $60^{\circ}$  north, while in winter time it extends from the neighborhood of the Tropic of Capricorn to beyond Iceland. The southern limit of the extra-tropical region of slight rainfall, on the other hand, experiences smaller annual variations, and extends in general in the spring time and autumn farthest towards the equator, while, on the other hand, in the southern hemisphere it retreats the farthest southward. By these variations in location and extent of the rain region a very different distribution of the rain with respect to the seasons of the year is brought about in the various portions of the ocean. (*Z. O. G. M.*, Vol. XV, 1880, p. 475.)

Hann has investigated the rainfall of Austro-Hungary and attempted the solution of several questions hitherto slightly touched upon, basing his studies upon monthly means for twenty years or more at ten stations. Some of his results may be expressed as follows: The mean departure of the rainfall for any month from the average rainfall for the whole period is called the mean variability; it increases with the magnitude of the rainfall itself, so that in general places of greatest rainfall have the greatest variability. From the mean variability of four stations he computes the probable error of the mean of ten years as  $\pm$  of 2 millimeters, whence it would require 840 years to reduce the probable error to one millimeter, whence we see the absurdity of giving the monthly sums of rainfall to tenths of millimeters. If we express the mean departures in percentages of the total rainfall, we find the average variability for Austro-Hungary to be 40 or 50 per cent. of the total value, and it requires from sixty to seventy years of observations to obtain a monthly mean of rainfall whose probable error is 5 per cent. of its whole value. The above demonstrates clearly how uncertain are the rainfalls deduced from observations for ten years or less, and how easily erron-

eous conclusions may be deduced from such short periods. By expressing the annual rainfall for each station as a percentage of the average of a long series, Hann studies the simultaneous distribution of relative rainfalls and the probability of wet or dry years. (*Z. O. G. M.*, XVI, p. 339.)

Wojeikof has collated the records of heights of water recorded on gauges in American fresh-water lakes, the Great Salt Lake, the Sea of Ladoga, the Caspian Sea, &c. He finds that in all cases the epoch of maximum water was in the beginning of the decennium 1860-1870, but the minimum of 1872-'73, is not so uniform; the Caspian Sea he denominates the greatest rain gauge and evaporimeter of the globe. (*Z. O. G. M.*, XVI, 1881, p. 288.)

Max Möller, of Flensburg, communicates the results of careful observations of the cirrus-clouds. He finds that when a barometric minimum is moving from west to east, the well developed cirri on the eastern edge of the cloud-bank have a principal striation from west to east and a combing-out—namely, a cross-striation toward the north; while in the rear of the cloud-bank with a clearing sky the principal striation runs from north to south and the comb-teeth point to the east. Such depressions throw out towards the west only a plume of cirri whose northern edge is bounded by a region of high barometric pressure, and in such cases the area of low pressure shows only a slight tendency to change of location. The absolute motion of the cirri is directed by the upper winds there prevailing, the striation on the other hand is controlled by the motion of the various strata of air relative to each other. The variable angle between the direction of the upper wind and the striæ of the cirri will probably give some conclusions as to the course of the isobars in the upper strata of air. (*Z. O. G. M.*, XVI, 1881, p. 246.)

Professor Winkelmann has attempted a solution of the question how large a geographical district should be included in a given special prediction as to the occurrence of rain. He considers the question from a purely statistical view, and proposes to determine for any given region how often rain occurs at one station without occurring generally at all stations, and how far we may go from one station without coming to those whose rainy weather does generally not occur simultaneously with that at the starting point. On applying his formulæ and methods to ten years of record at ten stations in Wurtemberg, he finds that on the average for any one of these stations the weather is the same as that prevailing at the other stations on eighty-five days out of one hundred, the extreme values being .87 in 1871 and .82 in 1867. Thus one prediction for the whole region will, on the average, suffice to secure 85 per cent. of verifications; the division into two smaller districts will raise this percentage to 87 per cent. (*Z. O. G. M.*, XVI, 1881, p. 236.)

Blanford has published the meteorological observations made by Dr. J. Scully in Western Thibet, in 1876, during "Shaw's Mission." These observations afford an excellent check upon the applicability of Hann's

formula (*Zeitschrift Bd. IX, 1874, page 198,*) for the distribution of moisture, and its excellent argument is shown by the following table:

Altitude.	Vapor tension.	
	Observed.	Computed.
<i>Meters.</i>	<i>Millimeters.</i>	
1840	3.7	—
1770	7.2	8.3
2680	6.5	6.1
3420	4.9	4.7
4900	2.8	2.8

(*Z. O. G. M.*, XVI, 1881, p. 170.)

Stelling has published an elaborate memoir on the annual periodicity of evaporation at Russian stations. The observations forming the basis of his work have been uniformly made with Wild's "Weighing Evaporimeter," and the installation of these instruments at the various stations have been carried out with great uniformity; moreover, the stations represent a very great variety of climates and the records extend through periods of three to seven years, beginning with 1872. Among the general results we notice that the annual minimum everywhere occurs with the minimum temperature of January; the maximum depends, however, upon the Continental location, with its resulting winds, as well as upon temperature. The relation between evaporation and rainfall is perhaps best seen by comparison between observations at St. Petersburg and Taschkent, while the variations due to slight variations in the immediate surroundings can be seen by comparing Pavlosk with St. Petersburg, twelve miles distant, or the stations at the observatory and in the city of Taschkent, as shown in the following table:

Station.	Years.	Evaporation.	Mean temperature.	Mean relative humidity.	Mean wind.	Total rain.
				<i>Per cent.</i>		
Petersburg .....	1873-79	230	4° 4	86	4.9	603
Pavlosk .....	1873-79	188	3° 8	86	3.6	654
Taschkent observatory .....	1873	1,416	14° 8	54	2.5	409
Taschkent City .....	1878	667	13° 1	65	0.7	393

(*Z. O. G. M.*, 1881, p. 119.)

Rénou has made some important studies upon the cloudiness in Europe. By combining his own observations with those of others, he finds the daily curve of cloudiness for Paris; then from a general survey of diurnal periodicity he finds a minimum at 10 or 11 p. m., and a maximum at 1 or 2 p. m. in Paris, with a second maximum in the early morning hours, this latter being particularly well marked in the United States. The annual curve for Paris shows a maximum in December, and two minima in April and September, respectively; but this curve

for Pekin is directly opposed to that for Western Europe; similarly the annual curve for Sitka is directly opposed to that for Norway. A chart of the world, showing lines of equal annual cloudiness (isonephelic) is given by Rénan, and although only a first approximation to the truth, yet it seems to justify the statement that for the whole earth the average cloudiness is not much above 50 per cent., possibly as high as 55 per cent. (*Z. O. G. M.*, XVI, 1881, p. 102.)

Schiaparelli has computed the annual diurnal period of moisture from observations made during thirty years at the observatory at Milan. He finds the variation of relative humidity is, as in nearly every other place, the converse of that of the temperature, as is shown by the following table:

Month.	Temperature of dew point.	Tension of vapour.	Relative humidity.	
			Range.	Mean.
December.....	+0.7	4.8	7.7	87.5
January.....	-0.5	4.4	7.4	86.7
February.....	+0.6	4.8	15.7	80.4
March.....	2.1	8.7	20.8	72.7
April.....	6.7	7.8	23.9	68.8
May.....	10.6	9.5	25.1	67.9
June.....	13.8	11.8	25.6	65.3
July.....	15.7	13.8	26.1	62.4
August.....	15.6	13.2	26.0	65.0
September.....	13.4	11.5	25.2	72.7
October.....	9.3	8.8	18.7	79.9
November.....	4.4	6.8	13.5	84.6
Year.....	7.8	8.5	.....	74.5

(*Z. O. G. M.*, Vol. XV, 1880, p. 417.)

#### VII.—MOVEMENTS OF THE ATMOSPHERE, WINDS, ETC.

Woeikof, the author of the concluding chapter of Professor Coffin's "Winds of the Globe," has given a review of his results with some modifications, from which we extract the following table relative to winds in Greenland:

Stations.	Prevailing winds.	
	Summer.	Winter.
Polaris Bay House.....	NE. and SW.....	NE. and E.
Fort Foulke.....	NE. and SW.....	NE.
Upernavik.....	N. and SW.....	N. and E.
Godthaab-Jacobshavn.....	E. and SW.....	E.
Sabine Island.....	N. and S.....	N.

He concludes that we can assume with great probability that in winter a very strong current of air from Northern Greenland blows along

the east coast of the island towards the cyclone in the neighborhood of Iceland. The following similar tables relate to the middle latitudes of North America:

Stations.	Prevailing winds.	
	Summer.	Winter.
Saint Paul's Island, Alaska .....		S.
Southern Alaska .....	SE. to SW.	N. to E.
Washington Territory .....	SW. to NW.	E. and SE.
Oregon .....	SW. to NW.	SE. and SW.
California .....	S. and W.	S. and SE.
Arizona .....	SE. and S.	N.
New Mexico .....	S.	W. and NE.
Utah .....	S. and W.	SW. and W. and N.
Eastern Rocky Mountain slope .....	SE. and S.	N. and NW.
Florida .....	SE. and SW.	NW., N., and NE.
Bahamas .....	E. and SE.	N. and NE.
Alabama .....	SE.	NW. and N.
Mississippi, Louisiana .....	SE. to SW.	N., NE., and W.

As showing how little the trade winds control throughout the year, we have but to study the mean annual wind direction with their resultants; thus even in the Northern Bahamas, where the ratio is most nearly such as would belong to the trade wind, we find that the resultant wind for the year is north  $87^{\circ}$  east, while at Florida Keys it is north- $76^{\circ}$  east. (*Z. O. G. M.*, XIV., 1879, pp. 1 to 18.)

Hann summarizes the results of observations by Kersten, Seward, and others, in regard to the climate of Zanzibar. He says atmospheric currents in Zanzibar deserve a special consideration, since the seasonal change in the winds is here the basis of all weather phenomena. The northeast monsoon (that in 1864 began to be perceptible some weeks after the passage of the sun southward through the equator, but attained its full force after the middle of December, when the sun had reached its extreme southern position) brings higher temperature, lower pressure, and higher moisture.

The opposite features characterize the southwest monsoon, which commences shortly after the second passage of the sun through the zenith, and at first is accompanied by calms, but from the end of March onward for three months continues almost uninterruptedly to blow as a fresh breeze. In July and August, however, the southwest wind fails again for some weeks, diminishing to a light breeze, and even occasionally for a few hours shifts again to a weak northerly wind; in October the southwest again blows with less strength, interrupted by many calms, which by November always get the upper hand, and by the end of the month give way to the northeast monsoon. Thus the southwest monsoon prevails for seven months; two months are changeable, namely, March and November, and only three months from the middle of December to the middle of March belong to the northeast monsoon. (*Z. O. G. M.*, 1879, XIV, pp. 22 to 24.)

The results of the observations of the wind made on the last arctic expedition of Captain Hall have been discussed by Weihrach. These data are very valuable to the meteorologist on account of the high latitude the large number of hourly observations, and the actual measurement of the wind velocity instead of the ordinary estimates of wind force. The distressing misfortune that befell Dr. Bessels in the employment of a chief computer who proved to be wholly untrustworthy is already known to meteorologists, and rendered it necessary that Weihrach should undertake the labor of an entire repetition of the computations, some of the results of which are given in the following table:

*Anemometric means for Polaris Bay.*

Month.	Number of days.	Mean resulting velocity, miles per hour.	Mean resulting direction.
Sept., 1871	-----	1.01	S. 49 31 W.
Oct., 1871	-----	8.75	N. 33 21 E.
Nov., 1871	18	6.78	N. 54 18 E.
Dec., 1871	29	3.90	N. 64 13 E.
Jan., 1872	30	5.47	N. 58 48 E.
Feb., 1872	29	7.37	N. 51 30 E.
Mar., 1872	26	8.71	N. 51 4 E.
Apr., 1872	30	2.09	N. 70 54 E.
May, 1872	31	3.65	N. 49 13 E.
June, 1872	27	0.66	N. 35 7 E.
July, 1872	23	1.53	N. 2 5 E.
Aug., 1872	31	0.62	S. 71 21 W.

*Anemometric means for Polaris House.*

Nov., 1872	30	6.08	N. 36 38 E.
Dec., 1872	31	12.15	N. 43 37 E.
Jan., 1873	31	2.32	N. 74 56 E.
Feb., 1873	28	8.61	N. 47 13 E.
Mar., 1873	31	8.20	N. 56 24 E.
Apr., 1873	30	3.72	N. 67 53 E.
May, 1873	31	3.50	N. 51 19 E.

The existence of a diurnal period in the velocity is very plainly shown by the observations at Polaris Bay, but less plainly by the observations at Polaris House, and Weihrach remarks that there is a great similarity between the diurnal period at Polaris Bay and at Dorpat, Russia. The diurnal period in the wind direction is not plainly shown for either of Captain Hall's two stations, which result is explained by the fact that the observations are only recorded to the nearest eight principal directions. (*Z. O. G. M.*, Vol. XIV, p. 170.)

Köppen has reviewed the important memoir published by Hann in 1879 on the diurnal periodicity of the wind as to velocity and direction. With regard to the force of the wind, it is shown that whatever may be the direction there is a diurnal periodicity in the force, such that—for example, at Vienna—the times of maximum and minimum are as shown in the following table:

*Maximum and minimum wind velocity at Vienna.*

Wind direction.	Maxima.		Minima.	
	Time.	Velocity in kilometers per hour.	Time.	Velocity in kilometers per hour.
N.....	1 to 2 p.m.	19.8	5 to 6 a.m.	12.1
NE.....	5 to 6 p.m.	12.5	5 to 6 a.m.	6.1
E.....	1 to 2 p.m.	10.3	5 to 6 a.m.	4.9
SE.....	1 to 2 p.m.	15.6	5 to 6 a.m.	8.2
S.....	3 to 4 p.m.	18.6	5 to 6 a.m.	7.5
SW.....	11 a.m. to noon.	15.3	3 to 4 a.m.	7.0
W.....	1 to 2 p.m.	35.2	7 to 8 p.m.	27.8
NW.....	1 to 2 p.m.	27.4	1 to 2 a.m.	21.5

This increase in wind velocity up to a maximum in the warmest part of the day is apparently confined to the lowest stratum of air and is to be attributed to the descent of rapidly-moving upper currents of air replacing that which is continually ascending from the heated surface of the earth. The only other plausible hypothesis would seem to be that the upper currents have a variable influence upon the lower strata, depending upon the variation of what is known as the internal friction of gases. The coefficient of this friction increases with the temperature, whence it might seem that stronger winds would be experienced at midday at sea-level than during the night-time, but coefficient ( $\gamma$ ) of friction, for the temperature  $t$  is, according to O. E. Meyer, equal to  $(1+0.0025t)\gamma_0$ , where  $\gamma_0$  is the coefficient at  $0^\circ \text{C}$ .

It is, however, believed that the diurnal variation of the temperature of the air at considerable altitudes is too slight to sensibly effect this coefficient. Köppen, therefore, considers that the greater part of the diurnal variation and wind force must be attributed to the descent of rapidly moving upper currents of air. This result is confirmed by the study of the relation of wind pressure and barometric gradient, and also by the study of the daily and annual variation in humidity. Köppen says, since the atmospheric pressure is influenced by the warming of the lower strata of air in the same direction as by the humidity, we can say that the greater the difference of air temperatures in a vertical direction the less is the difference in absolute humidity, barometric pressure, and total horizontal movement, so that in the early afternoon hours, as far as these elements are concerned, the inhabitants of the low plains may be said to, in a certain sense, be transferred into an atmosphere that belongs to a higher level, while the dwellers on the mountain tops are on the other hand transferred to a lower level. The reason why the trade-winds, and probably all winds, show on the open sea nothing or a very little of the midday maximum is explained by considering that the vertical circulation of air, as well as the increase of wind velocity with the altitude, is much less than over the land. (*Z. O. G. M.*, XIX, p. 348.)

Hann has, in a few words, set clearly forth the slight differences of



opinion that at present exist relative to the use of the term ascending current. Saussure first employed the term "*courant ascendant*," which Hann would restrict to the column of air ascending from mountains at midday, and he doubts whether a similar general ascending current ever developed itself over extensive horizontal areas of warm earth. That many meteorologists have described the daily ascent of the lower strata of air as going on continuously and not as a local interchange between ascending currents on the one side and descending on the other, is evident to all, especially when we consider how many have fruitlessly endeavored to explain the afternoon barometric minimum as the result of the ascending current.

Hann finds a strong argument against the invariable existence of an afternoon ascending current in the fact that frequently at Vienna, as elsewhere, absolutely cloudless afternoons occur, even when the dew-point at the earth's surface is so high that an ascent of a few thousand feet must produce cumulus clouds. The cumulus clouds that frequently occur at very great altitudes are seldom due to currents ascending from the immediate neighborhood of the observer, but to a rising and falling or wave-like movement in the upper current itself. At these altitudes the air is very near its dew-point, wherefore a very slight ascent would give rise to formation of clouds. The direct interchange of air between the upper and lower strata of the atmosphere seems not to extend to very great altitudes in the atmosphere. (*Z. O. G. M.*, XIV, p. 352.)

Köppen has published an extensive essay on böen, or wind gusts and thunder storms, which is reprinted with additions in the Journal of the Austrian Meteorological Association. He concludes by inclining to the belief that the gusts of wind preceding showers of rain are brought down by the friction and resistance of the falling drops. In this view, however, we believe that he was long since anticipated by Prof. Joseph Henry. In regard to the gusts accompanying the böen when no rain falls, he thinks that this consists of air brought down from the upper regions by its greater density, but still retaining the great horizontal velocity that prevails aloft.

The indications of the self-recording barometer show that every gust of wind is accompanied by a corresponding disturbance of the barometric pressure, and the table quoted by him furnishes many illustrations of this. These disturbances are additional to those caused by the action of the wind on the doors and chimneys of the room in which the barometer is placed, and relate to the motion and density of the air in the neighborhood of the observer. (*Z. O. G. M.*, XIV, pp. 457 to 478.)

Sprung remarks that the law according to which bodies moving horizontally are deviated to the right or to the left by the influence of the rotation of the earth, notwithstanding its importance for meteorology, appears to be still very little known. "In the course of my investigations it appeared clear to me that the reason why the theory of Hadley and Dove as to the influence of the earth's rotation on the wind is at the

present time applied to the explanation of the cyclonic movement of the air consists especially in its great perspicuity, but also equally in the difficulty of making a true law of deviation generally evident to readers slightly acquainted with mathematics. It appears to me, however, as though this difficulty could be overcome, and as though the correct expression for the deviating force of rotation could be deduced in a simple manner intelligible to all." Sprung then proceeds to consider the case of a plain disk rotating with an angular velocity  $\omega$ , which is a case precisely parallel to the condition of affairs on the earth's surface in the neighborhood of the North Pole. If the relative or absolute orbit of any body passes through the center of rotation of the disk, then, in the absence of all exterior forces, the body moves relatively to the earth in an Archimedean spiral, in such a manner that its relative angular velocity is equal to that of the disk itself, and perpetually moving further and further from the center.

This, therefore, is the inertia curve projected upon a rotating plane disk. It is now evident that every relative movement on the disk that differs from that of the inertia curve is also a departure from the absolute rectilinear movement, and can therefore not take place except under the influence of some exterior force. If, now, such exterior force be decomposed into components that are perpendicular and parallel to its orbit, the study of the combined effects of these components and the centrifugal force shows that on a parabolic surface rotating with the angular velocity  $\omega$  the inertia curve is a circle whose radius is  $\rho = -\frac{v}{2\omega}$  described with a constant relative velocity ( $v$ ) which is entirely independent of the distance from the center of rotation of the surface.

For movements upon the actual surface of the earth we have  $\rho = -\frac{v}{2\omega \sin \varphi}$ . The uniform motion in a straight line, or those forms of motion which, in absolute space, are the only ones that can exist in consequence of the inertia, requires, on the rotating surface of the earth, the action of an outer pressure from right to left capable of producing an acceleration at the equator, whose value is expressed by  $2 v \omega \sin \varphi$ .

Sprung, by geometrical construction, makes it evident that under otherwise similar circumstances in regard to the geographical latitude, the velocity and friction, 1st, the cyclonal curvature of the wind orbit is accompanied by a stronger gradient and greater angular deviation  $\varphi$  than is the anti-cyclonal curvature. 2d. For the same curvature of the wind orbit and for equal velocity and increasing coefficient of friction increases the gradient, but diminishes the angular deviation  $\varphi$ . 3d. For equal curvature of the wind orbit, and equal coefficient of friction, and equal velocity, both gradient and angle of deviation increase with the approach to the equator, as was shown by Guldberg and Mohn. (*Z. O. G. M.*, Vol. XV, 1880, pp. 1 to 21.)

Woeikof gives a summary of our knowledge of the winds on the Atlantic Ocean, in which, among other things, he gives the following table showing the mean limits of the northern border of the region of the northeast trade winds. Thus on 45th meridian west, from April to June, the average latitude of the northern limit of the northeast trade winds is  $27^{\circ}$ .

Season.	Meridian.									
	$65^{\circ}$ W.	$60^{\circ}$ W.	$55^{\circ}$ W.	$50^{\circ}$ W.	$45^{\circ}$ W.	$40^{\circ}$ W.	$35^{\circ}$ W.	$30^{\circ}$ W.	$25^{\circ}$ W.	$17^{\circ}$ W.
January - March .....	N. $26\frac{1}{2}^{\circ}$	N. $25^{\circ}$	N. $23\frac{1}{2}^{\circ}$	N. $23^{\circ}$	N. $24\frac{1}{2}^{\circ}$	N. $26^{\circ}$	N. $26\frac{1}{2}^{\circ}$	N. $25\frac{1}{2}^{\circ}$	N. $25\frac{1}{2}^{\circ}$	N. $28\frac{1}{2}^{\circ}$
April - June .....	$28^{\circ}$	$24\frac{1}{2}^{\circ}$	$32^{\circ}$	$25^{\circ}$	$27^{\circ}$	$29^{\circ}$	$28^{\circ}$	$28^{\circ}$	$28\frac{1}{2}^{\circ}$	$28^{\circ}$
July - September .....	$27^{\circ}$	$27^{\circ}$	$26\frac{1}{2}^{\circ}$	$26^{\circ}$	$26\frac{1}{2}^{\circ}$	$27\frac{1}{2}^{\circ}$	$27\frac{1}{2}^{\circ}$	$28\frac{1}{2}^{\circ}$	$31^{\circ}$	$31\frac{1}{2}^{\circ}$
October - December .....	$26^{\circ}$	$24^{\circ}$	$22\frac{1}{2}^{\circ}$	$22^{\circ}$	$22\frac{1}{2}^{\circ}$	$24\frac{1}{2}^{\circ}$	$25\frac{1}{2}^{\circ}$	$25\frac{1}{2}^{\circ}$	$26\frac{1}{2}^{\circ}$	$29^{\circ}$

(Z. O. G. M., Vol. XV, 1880, p. 124.)

In reference to the winds of the valley of the Upper Engadin in Switzerland, Professor Billwiller, in a review of the recently crowned essay of Dr. Ludwig, says, "After I had made an accurate review of the continuous records of the meteorological stations, and, by direct questionings of reliable persons, had found the fact confirmed that really on warm, clear summer and autumn days, about midday, there regularly prevailed a local wind flowing downwards in the direction of the river from Maloja Pass to beyond the Scaufs, which attained its greatest intensity in the warmer hours of afternoon, and toward evening again died away, I attempted to find an explanation for this phenomenon, which apparently stands in contradiction to the theory of the mountain and valley winds." The explanation of this phenomenon depends essentially upon the topographical peculiarities. The meteorological conditions of the Ober-Engadin are entirely the same as those of an inclosed valley. The temperature variations are much greater than those of the lower land beneath it, by reason of the dry, pure, thin air. The insolation in summer produces an ascent of the air on the flanks of the valley that is followed by a diminution in the pressure and density of the air immediately above the lowest portions of the long, narrow valley of the Inn, and which demands a compensation. Since now active ascending currents are moving along the southern base of the Alps, nothing is more natural than to assume that the deficiency in density in the base of the valley of the Ober-Engadin should find its compensation by drawing upon the cooler and somewhat denser air on the other side but at the same level in the valley of the Maloja.—(Z. O. G. M., Vol. XV, 1880, p. 297.)

O. T. Sherman has published the result of observations made by himself, in balloons, on the height and strength of land and sea breezes. The observations were made at Coney Island, near New York, at the expense of Capt. H. W. Howgate, and at the request of Professor Abbe,

who also furnished most of the instructions. These observations were taken every five minutes with barometer, thermometer, anemometer, &c. It is demonstrated, by means of these observations, that the return current of air is comparatively thin and feeble, and also that the sea wind, like the land wind, has only a feeble power. (*Z. O. G. M.*, XV, p. 448.)

Professor Airy has published the results of the reduction of the photographic records of pressure and temperature at Greenwich since 1849. The annual wind "roses" for these two elements are as follows:

[Direction of wind.	Pressure.	Temperature.
N.....	0.9	7.7
NE.....	3.8	8.3
E.....	2.5	9.1
SE.....	0.9	10.2
S.....	-3.8	11.1
SW.....	-2.2	11.2
W.....	-1.1	10.4
NW.....	-0.4	8.6

The monthly means, including those of earth temperatures, are shown in the following table. The air temperatures refer to the years 1849 to 1868, for the first part of the table; but for the sake of comparison with the earth temperatures they have, in the second part of the table, been recomputed for the years 1847 to 1873, and are given in degrees cent.:

Month.	Temperatures for 1849-'68.			Temperatures for 1847-'73.		
	Air.	Dew-point.	Perfectly clear days.	Air.	Earth at 6 feet.	Earth at 24 feet.
December.....	4.9	3.0	-3.6	4.7	9.2	11.2
January.....	3.7	1.9	-3.3	3.6	7.7	10.9
February.....	4.3	1.9	-2.2	4.3	7.1	10.5
March.....	5.3	2.3	+0.4	5.3	7.1	10.1
April.....	5.6	4.7	2.1	5.4	8.1	9.7
May.....	11.7	7.4	2.2	11.6	9.9	9.4
June.....	15.4	10.8	2.7	14.5	12.3	9.4
July.....	17.0	12.1	2.4	16.9	14.3	9.6
August.....	16.6	12.5	2.4	16.4	15.4	10.1
September.....	14.2	10.8	1.6	14.0	15.1	10.6
October.....	10.6	8.3	0.0	10.3	13.6	11.0
November.....	5.9	6.1	-2.6	5.9	11.3	11.2
Year.....	9.8	4.7	+0.2	9.7	10.9	10.3

(*Z. O. G. M.*, Vol. XV., 1880, p. 405.)

Professor Finger, of Vienna, has published a second memoir on the influence of the earth's rotation upon the winds. As several of his fundamental assumptions differ from those introduced by Ferrel, his results differ correspondingly. He concludes that the gradient in the horizontal direction perpendicular to the respective wind direction is entirely independent of the friction and other resistances to the motion of the air; and, again, that the influence of the ascending vertical movement is to depress the barometric pressure for south winds and raise it for north

winds. [This influence seems to relate to matters of minor importance as compared with those to which Professor Ferrel has confined his attention.] (*Z. O. G. M.*, XVI, 1881, p. 532.)

Dr. A. Sprung gives an elucidation of the theoretical considerations explanatory of his conclusion that the daily period in wind force is a necessary consequence of a daily period in wind direction and velocity. He finds for a period of cloudless weather in Magdeburg the following mean velocities recorded by the meteorograph of Dr. Assmann.

Magdeburg records.			Hamburg records.		
Hour.	Wind direction.	Wind velocity.	Hour.	Wind direction.	Wind velocity.
	°	Meters per sec.		°	Meters per sec.
8-9 a.m. ....	N. 80.6 E.	5.1	0-2 a.m. ....	N. 63.2 E.	4.6
9-10 a.m. ....	86.0	5.8	2-4 a.m. ....	59.7	4.3
10-11 a.m. ....	85.8	6.2	4-6 a.m. ....	66.5	4.2
11-12 m. ....	87.2	6.3	6-8 a.m. ....	78.9	4.8
12-1 p.m. ....	87.5	6.3	8-10 a.m. ....	80.8	5.6
1-2 p.m. ....	90.8	6.5	10-12 m. ....	78.8	6.7
2-3 p.m. ....	87.1	6.6	12-2 p.m. ....	80.8	6.8
3-4 p.m. ....	87.3	6.3	2-4 p.m. ....	76.2	6.8
4-5 p.m. ....	86.7	6.4	4-6 p.m. ....	66.2	6.3
5-6 p.m. ....	82.7	5.5	6-8 p.m. ....	70.9	5.1
6-7 p.m. ....	82.3	4.8	8-10 p.m. ....	62.9	5.0
7-8 p.m. ....	75.6	4.6	10 midnight.	62.4	5.0
8-9 p.m. ....	72.5	4.9			
9-10 p.m. ....	70.7	5.1			

These show a wind force increasing as the wind veers toward the east in the morning, and diminishing in the afternoon as the wind backs to NE. A general summary, based on records from 18 stations in Europe and Asia, shows that the number of plus or minus revolutions of the wind-vane is as follows:

Morning, + 4185 - 2617

Afternoon, + 2885 - 3267

whence the Dove law of winds is not confirmed for the afternoon interval 1 p.m. to 9 p.m., but is perfectly so in the morning hours. The "Espy-Köppen" theory of the diurnal variation of the strength of the wind requires that no such period should exist at considerable altitudes above the earth, and this is confirmed by the observations taken on Schaffberg and Pic-du-Midi. (*Z. O. G. M.*, XVI, 1881, p. 424.)

Sprung has continued his theoretical investigations on the wind by adding a few empirical results as to the relation between the force of the wind, the gradient, and their diurnal periodicity. Expressing the wind force (*S*) on the Beaufort (0 to 12) scale, and the gradient in millimeters of the barometer for 111 kilometers (or millimeters for degree of latitude), he finds in general:

$$\text{Gradient} = 0.5 + 0.212 S + 0.019 S^2.$$

For the same gradient the wind force is greater for north and east winds than for south and west winds, also greater in summer than in winter. The diurnal variation in wind force during clear days is much

greater than during cloudy days. The range for the former is, in the summer season, twice that for the latter. For clear days the range of wind force is remarkably great, while the gradient remains unchanged, a condition that requires the introduction of an explanation in the manner suggested by Köppen (*Z. O. G. M.*, XIV, pp. 333-349.) At sea the diurnal range, as deduced for marine records, shows nothing of all this remarkable increase of wind force at 2 p. m. Finally, Sprung compares the anemometer records at 4 stations with the corresponding estimates on the Beaufort scale, and deduces the following formula:

Velocity in meters per second =  $0.360 + 1.691 \times$  Beaufort scale of force. (*Z. O. G. M.*, XVI, 1881, p. 356.)

The above work by Sprung has been followed by a similar study by Rev. W. Clement Ley, who has discussed the observations at Stonyhurst and Kew, and who concludes that if we could have isobars for the level of the cirrus clouds, we would there find above the deepest cyclone only a slight secondary depression circulating around a portion of the great polar depression. He submits the question "Cannot the fact that a given gradient for east winds obtains only in the lower atmosphere, while a similar gradient for west winds holds good for the whole atmosphere, be brought into connection through known laws of mechanics with the fact of the greater force of the east over the west winds at the earth's surface?" (*Z. O. G. M.*, XVI, 1881, p. 535.)

Supan, professor of geography in the University of Czernowitz, has published a valuable work, entitled "*Statistik der unteren Luftströmungen*," in which he has utilized the great collection of data published in Coffin's "*Winds of the Globe*" (Washington, 1876), and almost as much more collated by himself. Supan has, in fact, endeavored to utilize only the longer series of observations, and he confines himself to annual percentages of the frequency of the winds, omitting the calms, which are not given with sufficient accuracy and uniformity by the various observers. Only about thirty pages of the whole volume are occupied with general analysis and conclusions.

In elucidating the mutual relations of wind and pressure, Supan calculates the pressure for January over the N. Atlantic Ocean at various altitudes and degrees of latitude. Adopting observed pressures at sea-level and Glaishers' rate of diminution of temperature with altitude, Supan obtains the pressures in the following table:

Lat.	Pressures.					Differences of pressure.				
	Altitudes in meters.					Altitudes in meters.				
	0.	2,000	4,000	6,000	8,000	0.	2,000	4,000	6,000	8,000
0										
30	755	572	428	316	232	- 3	-28	-41	-49	-50
60	744	576	441	334	251	-14	-24	-28	-31	-31
90	766	601	467	360	275	+ 8	+ 1	- 2	- 5	- 7
0	758	600	469	365	282	0	0	0	0	0

Whence it appears that at 3000<sup>m</sup> a uniform downward gradient prevails from the equator to the pole, and that this gradient is stronger the higher we ascend above that level. (*Z. O. G. M.*, XVI, 1881, p. 402.)

A. Richter has studied the relations of the upper cirrus cloud movement to the distribution of pressure and temperature at the earth's surface, basing his studies upon the cloud observations of the years 1878-1880 at Ebersdorf, and the daily weather charts of the Deutsche Seewarte. He finds for the average of the three years that the upper clouds move towards the azimuth S. 85° W.; the angle by which the movement of the cirrus differs from the barometric gradient averages 88°, and that by which it differs from the corresponding temperature gradient is 75°. The changes in these average results depending upon the seasons the direction of the wind, excessive gradients, &c., are also investigated somewhat. (*Z. O. G. M.*, XVI, 1881, p. 376.)

L. Teisserenc de Bort, in a study upon atmospheric circulation in the Iberian peninsula, says: "The simultaneous observations, day by day, assume greater importance, but this new mode of research cannot wholly replace studies by the method of averages in many of the problems that meteorology offers us. Averages are, in fact, a powerful means of bringing out the dominant character of phenomena, and they are applicable to the discussion of daily charts as well as to the so-called statistical researches. These latter do not show the accidental variations, but they put in relief certain influences that play an important part because of their continuous action, and that are too feeble to clearly stand forth in the portrayal of the general condition that obtains at any moment. (*Z. O. G. M.*, XVI, 1881, p. 265.)

F. Chambers has discussed with much ability the record for 1873, '74, '75 of the anemograph, at Kurrachee, in a memoir of some length. (*Z. O. G. M.*, XVI, 1881, p. 172.)

Ragona has published a memoir on the diurnal and annual variations in the direction of the winds, basing his studies upon the hourly readings from the self-register of the observatory at Modena. He finds four daily maxima and four minima in the velocity of the wind during January, February, October, and December, three maxima and minima during March, June, July, and August, September, and November, and two maxima and minima during April and May. The connection between diurnal periodicity in velocity and direction is so close that he then finds almost a perfect parallelism in these two data. As to the annual periodicity he finds for each wind direction two maxima and two minima of frequency; he also finds Dove's law of rotation of the winds confirmed for Modena. (*Z. O. G. M.*, XVI, 1881, p. 125.)

#### VIII.—BAROMETRIC PRESSURE.

#### IX.—STORMS.

Köppen, in a review of the extensive work of Toynbee on the "Meteorology of the North Atlantic during August 1873," gives a study of the

relation between isobars and winds during the great hurricane that marked this month. The angle between the wind and isobar in each quadrant of the hurricane is as follows, on the average of three maps:

Quadrant.	Angle $\psi$ .	Number of observations.
NE .....	48°	25
SE .....	64°	11
SW .....	70°	41
NW .....	60°	31
Total..	61°	108

At different distances from the storm-center the angle varied as follows:

Distance in nautical miles.	Angle $\psi$ .	Number of observations.
100	47°	7
200	57°	17
300	62°	18
400	58°	32
500	65°	12
600	68°	7
700	75°	12
800	75°	3

Since these relate to the region beyond the maximum of wind force they can, according to Guldberg and Mohn, be considered as approximations to the normal values of the angle of deviation, and in their notation the average values for the three maps are as follows:

Date.	$\psi$	Number of observations.
August 24, 10 <sup>h</sup> p. m. ....	61	37
25, 6 <sup>h</sup> a. m. ....	59	40
25, 0 <sup>h</sup> 43 <sup>m</sup> p. m. ....	64	31

This angle is, therefore, nearly the same on the Atlantic Ocean, and in latitude 42°, as it is in Denmark and Great Britain. By the formula given by Guldberg and Mohn we can now compute the coefficient of friction and derive the value  $k=0.00005409$ . With this we may compare the value  $k=0.00007265$ , computed by Hoffmyer, for Denmark, latitude 56°, from the deviation angle  $\alpha=59^\circ$ , and we find it higher than would have been expected from the ocean (Guldberg and Mohn assume for the open sea  $k=0.00004$ ). The value  $k=0.00002582$ , computed by Clement Ley for  $\psi=77^\circ$  for five British coast stations is apparently much too small. (*Z. O. G. M.*, XV, 1880, p. 201.)

Friesenhof concludes from the study of the paths of storm centers that the most important factor in determining both the velocity and direction of the progression is the unequal evaporation in the different



quadrants—the greater the inequality the faster the movement. In the North Atlantic Ocean this evaporation is largely dependent upon the presence of open water or a covering of ice, whence he is led to conclude that the storm paths of this region may be classified in two periods. The first is that of the frozen East Polar Sea, with floating ice in the West Polar Sea, which period is marked by great frequency of depressions over the Atlantic and their movement southward into the interior of Russia. The second period is that of the frozen West Polar Sea, with less ice in the East Polar Sea, which period is marked by fewer Atlantic cyclones, which all pass from the Gulf Stream into the East Polar Sea. There is no regularity in the duration of these periods, although there is some appearance as if the first belonged to the winter and the second to the summer season. (*Z. O. G. M.*, XV, 1880, p. 217.)

J. Elliott has published an elaborate report of the Madras cyclone, May, 1877, in which he contributes much to the knowledge of the circumstances attending the inception of the cyclones of the Bay of Bengal. He says that it is doubtful whether there is in all cases a single calm center which continues unbroken during the continuance of the cyclonic disturbance in its more intense form and the path of which marks the line of advance of the cyclone. It is quite probable that, with the intermittent actions of the winds, one of the commonest features of cyclones being rapid variations in their intensity, which give rise to the well known phenomena of squalls, there may be a continuous disappearance of one storm center and the formation of another in its neighborhood.

The only entirely new and adequate factor in the meteorological conditions present during the origin and existence of this cyclone was rainfall; the cyclone gradually developed after the rainfall, and its intensity, bears the most direct and marked relation to the intensity of the rainfall. It followed the line of heavy rainfall throughout its existence.

The energy of the latent heat given out produces an ascensional or expansional movement in the atmospheric condensing region, and this disturbance is followed by an attempt towards equilibrium, which in this case is the converging motion of the lower atmospheric strata to the area of rainfall. (*Z. O. G. M.*, Vol. XV, 1880, p. 308.)

Ragona has published a work on the general movement of the atmosphere, and the prediction of the weather in especial reference to Italy. He states that the barometric depressions approaching Italy from the northwest and south pass around the peninsula rather than over it. About the same number of depressions approach from all directions. (*Z. O. G. M.*, XVI, 1881, p. 452.)

Dr. Van Bebber has studied the daily and monthly course of the barometric minima in Europe, 1876–1880, and endeavored to contribute toward bridging over the gap between climatological studies based on monthly and annual means, and those based on daily weather maps. In studying the statistical distribution of minima, he constructs a map, showing the average number of minima passing through each square of

50° latitude and 10° longitude. [In the statistical atlas published by the United States Census Office in 1876 may be found a similar chart for each one degree square for the United States.]

Van Bebber finds, however, that the irregularities in contiguous years are such as to show that five years is by far not enough to establish the normal distribution of storm-centers.

The following table shows the annual means for each zone, corrected so as to reduce to a uniform area with the zone of 50° latitude:

Latitude.	Annual number.	Means.
0		
40-45 N.	18.0	18.0
45-50 N.	11.6	11.6
50-55 N.	{ 18.8 continental. 13.0 oceanic. }	15.9
55-60 N.	{ 19.8 continental. 23.4 oceanic. }	21.1
60-70 N.	20.0	20.0

In reference to the paths pursued by the minima, Van Bebber finds the routes most frequented to be as follows:

(A) Passing through Northwestern Ireland; then along the coast of Norway into the Arctic Circle; thence dividing and passing on either (1) northward until swallowed up in the ocean, or (2) to the White Sea, or (3) southeast to the interior of Russia.

(B) Passing near Great Britain; thence either directly over the North Sea, Southern Scandinavia, central and southern Baltic Sea to Finland and the Baltic provinces of Russia.

(C) Passing southwest of Great Britain, southeastward over France to the Mediterranean.

In general, the minima seem to prefer the coast; mountains do not apparently attract them. (*Z. O. G. M.*, XVI, 1881, p. 418.)

Riniker has studied the mass of data collected by the forestry commission of Aargau, Switzerland, relative to the occurrence of hail. He finds an intimate connection between the frequency and severity of hail storms and the distribution of forests, cleared land, &c.; the more forests, so much the less hail. (*Z. O. G. M.*, XVI, 1881, p. 525.)

Lancaster, of Brussels, has discussed the observations of thunder storms in Belgium during 1878. He finds the trend of the paths of the 43 storms distributed as follows: Toward the SW., 25; S., 8; SE., 4; W., 4; NW., 1; NE., 1. The hourly velocity of progress averages 5 kil. On the average of 45 years, 1833 to 1878, the annual distribution of days with thunder is as follows:

Number of storms.		Number of storms.	
January .....	12	July .....	158
February .....	10	August .....	159
March .....	27	September .....	68
April .....	45	October .....	21
May .....	108	November .....	6
June .....	143	December .....	4

The diurnal periodicity is as follows :

Interval.	No. of storms.
Midnight to 2 a. m.....	27
2 a. m. to 4 a. m.....	26
4 a. m. to 6 a. m.....	15
6 a. m. to 8 a. m.....	16
8 a. m. to 10 a. m.....	18
10 a. m. to noon.....	57
Noon to 2 p. m.....	115
2 p. m. to 4 p. m.....	143
4 p. m. to 6 p. m.....	173
6 p. m. to 8 p. m.....	141
8 p. m. to 10 p. m.....	75
10 p. m. to midnight.....	37

(*Z. O. G. M.*, Vol. XVI, pp. 369-372.)

Schiaparelli and Frisiani have prepared a study of the observations of thunder storms made in Upper Italy during 1877. The latter finds that the greater part of the storms occur when a barometric maximum is present on the Atlantic coasts of France and England, and pressure is high on the north side of the Alps; a smaller proportion of the storms occur when the maximum barometer is over Northern Africa; very few occur when the maximum is over Upper Italy, and only when clear warm days prevail. None occur when the weather is perfectly clear, with uniform high pressure, or when the minimum pressure is due west or the temperature too low. No encouragement is found as to the probability of our being able to predict local thunder storms. (*Z. O. G. M.*, XVI, 1881, p. 360.)

The distribution of thunder storms in Zürich during the past ninety years has been studied by the scientific society in that city, the summary of which is given by Hann. The daily records for this period show 1,734 thunder storms with thunder and lightning, 217 lightning without thunder, and 368 hail storms, of which 116 are included in the above 1,734. The annual distribution of these storms by ten-day periods show two maxima of 155 each, viz, the 11th to 20th of June, and 10th to 19th of August. (*Z. O. G. M.*, Vol. XVI, p. 349.)

#### X.—ELECTRICITY, MAGNETISM, AURORAS, ETC.

H. Fritz has published a very complete summary of the present state of our knowledge of the aurora (*Das Polarlicht*, Leipzig, 1881). We quote the following:

(1) The region of greatest frequency is in the neighborhood of the Arctic Circles, touching North Cape and Point Barrow, and at its southernmost passing through Northern Labrador. This generalization was first published by him in 1867, but in the present work is revised by the help of his great catalogue of auroras, published in 1873.

The relative frequency of auroras for stations nearest the zone of

maximum frequency is shown in the following table, where the fourth column (B) contains the total number of auroras observed at the given stations during the years for which we have the record, the fifth column (E) gives the number of auroras recorded in Fritz's catalogue as having been observed in Central Europe during the same years, and the last column (M) gives the mean relative frequency of visibility of the aurora for the respective places for the interval from 1700 to 1872, as computed by the formula

$$M = 28 \frac{B}{E}$$

Station.	Latitude.	Longitude.	B.	E.	M.
	°	°			
Makerstoun	56 N.	3 E.	184	197	28
Dunse	56 N.	2 E.	238	166	41
Christiania	60 N.	11 E.	965	1,149	23
Upsala	60 N.	18 E.	1,150	1,359	28
Enare	69 N.	24 E.	358	460	25
Ericknaess	63 N.	22 E.	537	712	21
Sandwick Manse	59 N.	3 E.	405	292	31
Tronthelm	63 N.	11 E.	85	13	195
Øyvig	70 N.	23 E.	23	6	107
Kaafjord	70 N.	24 E.	111	20	155
Kilduin	69 N.	33 E.	53	85	42
Nova Zembla	73 N.	54 E.	51	61	33
Do	73 N.	53 E.	16	10	45
Werschene Kolymak	66 N.	151 E.	30	41	20
Nyschne Kolymak	69 N.	161 E.	65	5	364
Iceland	65 N.	20 W.	149	81	51
Do	65 N.	20 W.	300	211	39
Baerentz Island	75 N.	20 E.	18	12	31
Spitzbergen	79 N.	15 E.	4	2	56
Do	80 N.	16 E.	100	86	32
Frans Josef Land	78 N.	60 E.	249	164	43
Saint Lawrence, N. Y.	43 N.	71 W.	308	322	27
Sommerville, N. Y.	43 N.		178	165	32
Utica, N. Y.	43 N.	75 W.	174	211	23
Sauk City	43 N.		323	406	22
Toronto, Canada West	44 N.	79 W.	1,242	949	37
Depauville, N. Y.	44 N.	76 W.	212	479	34
Franklin, Mo.	45 N.	70 W.	61	40	43
St. Martin	46 N.	74 W.	403	858	32
Albion Mines	46 N.		63	165	28
Quebec	47 N.	71 W.	229	322	20
Metawagomingen	47 N.	80 W.	40	45	25
Michpocoton	48 N.	85 W.	79	84	26
Moose Factory	51 N.	81 W.	294	121	64
Fort Albany	52 N.		61	57	30
Martin's Falls	52 N.		79	40	55
Cumberland House	54 N.	102 W.	46	10	129
Fort George	54 N.	128 W.	57	58	28
Fort Chipewyan, &c.	59 N.	111 W.	182	35	146
Pelly and Lewis	61 N.		129	154	23
Fort Simpson	62 N.	121 W.	253	148	48
Frances Lakes	62 N.	129 W.	66	19	97
Fort Hope	63 N.	131 W.	39	18	61
Fort Reliance	63 N.	109 W.	200	11	Max.
Fort Enterprise	64 N.	113 W.	148	8	Max.
Fort Normann	65 N.	125 W.	32	18	50
Fort Franklin	65 N.	123 W.	49	11	125
Yukon	66 N.	147 W.	24	20	34
Peel's River	67 N.	134 W.	201	238	24
Fort Confidence	67 N.	118 W.	198	93	60
Kotzebue Sound	70 N.	163 W.	32	8	112
Felix and Sheriff Harbor	70 N.	92 W.	25	51	56
Point Barrow	71 N.	156 W.	256	78	92
Fort Canada	72 N.	94 W.	89	28	39
Lancaster Sound	74 N.	81 W.	9	3	94
Winter Harbor	75 N.	111 W.	27	10	76
Godthaab	64 N.	52 W.	481	133	101

Even if the periodicity of the phenomena has a partial influence upon its magnitude and frequency, still it must, beyond all doubt, be that

north of the line of greatest frequency toward the Pole the frequency and magnitude of the aurora diminishes more rapidly than toward the Equator, although for no place in that zone is the aurora entirely invisible, as is the case in lower latitudes.

(2) With regard to the direction in which auroras are seen, after discussing a large number of observations, the author finds that the lines of greatest frequency and neutral directions are, in all probability, subject to periodical changes in frequency and extent, whereby they soon come nearer the Pole and again depart from it, as, in fact, could have already been suspected from the different altitudes and positions of the observed segments, arcs, &c.

(3) As regards the distribution of auroras in space, the author concludes that the great part of the auroras has no great extension, or the phenomenon is produced by conditions which are very local in their nature.

(4) In regard to the altitude of the aurora above the earth's surface, the author states he can make no advance on the conclusions previously formulated by others. The altitudes above the earth's surface at which polar lights develop are very various, and the altitudes of these regions, at least for the lower limit, diminish with the latitudes.

(5) The extent of the aurora and the duration vary within wide limits. The greatest extent in latitude has been from  $29^{\circ}$  south up to  $82^{\circ}$  north, and the greatest in longitude has been about  $280^{\circ}$ . The greatest duration has, apparently, been from August 28 to September 7 [1859].

(6) With regard to diurnal period, he finds that the aurora attains only one maximum and one minimum; the former is usually about 10 p. m., the principal exception being at Point Barrow, where the maximum would appear to be at 3 or 4 p. m.

(7) In regard to the annual period, nearly all the series of observations show two maxima and minima.

(8) In regard to the eleven year and the secular periods, it would appear that the periodicity of the aurora can be determined more accurately in proportion as we know the periodicity of the sun spots.

(9) The following table shows the comparison between apparent sun spots and auroras, so far as both of these data can be gathered from imperfect records:

*Dates of maxima and minima of observed number of auroras.*

Maxima.		Minima.	
1707.2	1804.5	1712.1	1810.8
1719.7	1818.5	1723.5	1822.2
1730.5	1829.9	1734.6	1834.1
1739.8	1840.2	1744.1	1843.8
1748.8	1850.1	1755.4	1856.3
1760.9	1860.6	1766.1	1865.6
1772.8	1870.9	1775.2	
1778.0		1783.4	
1788.3		1799.9	

(10) The mean length of the period from one maximum or minimum to the next is as follows:

	Years.
For the minima, 1712 to 1865.....	10.96
For the maxima, 1707 to 1870 .....	10.91
Average .....	10.94

(11) With regard to the secular period, Fritz computes as follows:

	Periods.	Duration.
From 208 B. C. to 1848.....	37	55.6
From 397 A. D. to 1848.....	26	55.8
From 503 A. D. to 1848.....	24	56.0
From 807 A. D. to 1848.....	19	54.8
From 1401 A. D. to 1848.....	8	55.9

From the above he deduces the mean length of the secular period as 55.6 years, or exactly five eleven-year periods of 11.12 years each.

He suggests that in the present relation between auroras and terrestrial magnetism a portion of the periodical variability may be due to the displacement of the existing distribution of terrestrial magnetism, and be therefore to a large degree apparent.

(12) In reference to the connection between auroras and the disturbances of terrestrial magnetism, he concludes that auroras and magnetic perturbations frequently occur simultaneously or follow each other closely; that, however, the perturbations that coincide with auroras are not observed at all magnetic stations, and that probably auroras occur without being announced by perturbations in terrestrial magnetism. In most cases the aurora precedes the stronger deviations of the needle.

(13) Again, in reference to the daily magnetic periods, he finds that the 10 p. m. maximum of auroras entirely corresponds with daily minimum of declinations, which latter, like the maximum of auroras, comes later with increase of latitude, and that, moreover, it agrees with the minimum of inclination or with the maximum of the intensity for any one single place, for instance, St. Petersburg, or with the secondary maximum of inclination of other places, such as Toronto, Hobarton, &c., and the maxima of auroras only agree with the secondary maxima of the disturbances. Herein it is established that the connection between the changes in the terrestrial magnetism and the aurora is indirect, and at present the appearances are that both these phenomena are influenced by a common cause, or perhaps are due to it.

(14) With reference to connection with *annual* periods of terrestrial magnetism Fritz says that the relations are more intimate; thus, the daily variation of declination, as observed at Munich, Hobarton, Floeberg Beach, show annual changes in their amplitude coinciding with the changes in frequency of auroras.

(15) With reference to the relation between auroras and sun spots, the author sums up the present state of our knowledge as follows: The maxima of the sun spots accurately or very closely agree with the quadratures of the planets Jupiter and Saturn. The differences are smallest in those periods in which the spotted surface is greatest upon the sun, when the auroras are the most frequent and most beautifully developed, as in the years 1638, 1648, 1718, 1727, 1738, 1837, 1848. The two longest periods (1660 to 1675 and 1789 to 1804) correspond to the times of quadratures (1668 and 1797), for which times, according to the previous observations, correspond no maxima. From these quadratures of Jupiter and Saturn, Fritz computes again the greater aurora period as 55.56 years.

(16) The eighth chapter deals with the relation between the aurora and the electricity of the atmosphere and the earth. The electric nature of the aurora is in general sufficiently well acknowledged, and some detail of aurora phenomena can be reproduced in the electrical experiments of our physical laboratories, but a satisfactory general theory as to the exact explanation of the auroral phenomena has not yet been accomplished. No evidence of the existence of free electricity in the air was observed in delicate experiments in the Arctic regions, made by Parry, 1819 to 1825, Fisher 1824, Franklin 1825 to 1827, McClintock 1857 to 1859, Bessels 1872, Nares 1875. But traces of electrical phenomena are claimed to have been observed by Wyjkander at Spitzbergen, 1872 and 1873, and by Hjaltalin, in Iceland, and by Canton, in London. The diurnal periodicity of atmospheric electricity, the annual periodicity, and the secular periodicity have all been the subject of observation by Schubler, Quetelet, Everett, Wisliczenus; but no definite relation between auroras and electricity can be deduced from these observations. The relation between frequency of thunder storms and auroras has been maintained by some; but the result announced by Von Bezold, namely, that the maximum of auroras occurs at the time of the minimum of thunder storms is directly controverted by Fritz, whose studies cover a longer period and a larger number of stations, and demonstrate that there is no definite relation between the two phenomena. On the other hand, the relation between thunder storms and sun spots seems to be more definite: at least Fritz finds that the maxima and minima of thunder storms do not correspond to the maxima and minima of sun spots.

A further connection apparently exists between auroras and the disturbances that are experienced on telegraph lines due to the so-called earth currents. This phenomenon was first observed, 1848, by Mattenci on the telegraph line between Pisa and Florence during the aurora of October 17, 1848; this phenomenon was also widely observed in Europe and America during the great aurora that lasted from August 28 to September 2, 1859; other dates of equal or greater disturbance were 1869, May 13; 1870, April 5 and October 24 and 25; 1872, February 4; the observa-

tions during this latter were among the most extensive ever taken. In general the disturbances are the greatest on telegraph lines that intersect the meridians; but decided exceptions to this rule are sometimes recorded.

Again, in general the optical phenomena follow after the disturbances experienced on the telegraph lines, and the latter die away rapidly after the maximum of the optical display, but sometimes the earth currents disappear with the first appearance of the optical phenomena. It is probable that a thorough investigation of this subject would be advantageous both for science and the telegraph companies.

As to the explanation of the origin of earth currents, Kuhn in 1861 believed that it is to be sought for in the earth and not the atmosphere. Balfour Stewart endeavors to prove that the auroras are secondary currents due to small, sudden changes in the terrestrial magnetism. Henry found evidences of atmospheric electricity when snow-fall occurs at one station while the heavens are clear at the other stations.

(17) As to the relation between the aurora and the weather, numerous attempts have been made to deduce some connection between the aurora and the general atmosphere. After giving the belief current among the natives of Arctic regions as recorded by explorers during the past hundred years, Fritz gives in detail some of the results of more careful study. Thus, Dalton finds the aurora to be a precursor of clear, fine weather in England. He also found a slight evidence in favor of the conclusion that the barometer would rise on the day after the aurora. Hansteen, from his long series of observations at Christiania, found that a lower temperature almost invariably follows an aurora, at least throughout Sweden, while throughout the north of Siberia the natives maintain that storms of wind and rain accompany the aurora. Collecting these and other generalizations together in tabular form one sees at a glance that the apparent connection between the aurora and weather is a local accident peculiar to the individual place under examination, and that we are justified in denying the existence of any influence of the aurora upon the weather, but upon the other hand the influence of the weather upon the aurora is not thereby denied. The relation between the aurora and the temperature of the air cannot be satisfactorily proven with the observations at present available. The aurora does not occur at the time of the lowest temperature of the day, nor does it directly follow the annual temperature changes that, according to Köppen, closely correspond to the sun spots.

(18) The relation between aurora and barometric pressure seems to admit of more exact description. Thus, an examination of twenty-three stations gives the diurnal maximum of auroras at 10 p. m., and the barometer maximum at 10 hours and 20 minutes p. m. Again, the annual periods of the barometer and aurora are so related that the minimum pressure corresponds to the maximum of auroras. As regards the secular periodicity of the barometer and the aurora, Hornstein, from an examination



of the records since 1763, finds the values of the annual variations of barometric pressure at Prague, Milan, Vienna, and Munich, are satisfactorily presented by the assumption that the longer period in these variations agrees with the longer period of the auroras, and these phenomena attain their maxima and minima at the same time; on the other hand, F. Chambers, from the barometer records at Bombay, arrives at the opposite result, namely, that the maxima of auroras correspond with the minima of barometers; but the discrepancy between these results may be only apparent when once we are able to properly appreciate the facts deduced by Forssman (Upsala, 1873), who arrived at the following results:

(a) Definite variations in barometric pressure are observed during strong magnetic disturbances or auroras that extend beyond their appropriate zones.

(b) The barometer variations have opposite signs in different portions of Europe, and probably also America.

(c) The limit between the regions of opposite signs is determined, at least in Europe, by a line that begins north of Scotland and passes southeastward through the Black Sea.

(d) During the presence of auroras and magnetic disturbances the barometer rises, or is at its maximum, in the region northeast of this line, and sinks, or is at a minimum, in a region southwest of this line.

(e) In the southwestern region the barometer is either rising or falling according as the magnetic horizontal component is very large or small; the opposite is probably true in the northeastern portion.

If Forssman's conclusions are confirmed by future investigations, then it will appear that the relation between auroras and the weather is far more complicated than has been hitherto assumed.

(19) The relation between aurora and polar bands has long been believed to be quite definite. These relations show themselves not only in the frequent simultaneous appearances of the two phenomena, but also in the frequent auroral form of the clouds known as polar bands, which, indeed, allow one to conclude the action of the polar force within them simply by reason of their peculiar arrangement as parallel streaks and regularly broken or stratified groups. There is here an undeniable relation, either direct or indirect. Among the numerous relations recorded by various observers quoted by Fritz, we cite the following: Humboldt observed that the vanishing-point of the polar bands moves gradually from east to west. Cramer states that the auroras change themselves into clouds, the whole heavens being covered with clouds if the phenomena lasts for a sufficiently long time. At Upsala, February 4, 1874, a ring of green color was observed around the moon during a fine aurora. From the observations at Bossekop, Bravais deduced the mean direction of the cirro-cumuli E.  $28^{\circ}.3$  N., while for the auroral arcs it was E.  $21^{\circ}.6$  N. Stevenson, at Dunse, in Scotland, found the annual frequency of cirrus clouds to run parallel with the frequency of the auroras. Winnecke, from observations at Poulkova, concludes that the cirrus

must undoubtedly be considered as the carrier or agent of the aurora phenomena. Weber and Klein and others give other data to show the connection between the aurora and cirrus, such as, that the times of greatest frequency of auroras and sun spots are also the times of greatest frequency of the polar bands.

There is also intimate connection between halos and other optical phenomena and the cirrus. Observations of this character have been discussed by Sophus Tromholt, of Norway, who finds for Northeastern Europe the following results:

Year.	Solar halos, &c.	Auroras.
1857	7	2
1858	15	5
1859	27	13
1860	24	7
1861	20	11
1862	16	9
1863	19	4
1864	9	4
1865	42	18
1866	29	13
1867	18	17
1868	18	5
1869	24	17
1870	23	22
1871	47	22
1872	32	18
1873	36	15

The parallelism between every form of atmospheric phenomena and the record of solar spots shows the connection to be a real one, although the *rationale* of the connection is not yet made clear.

Further elaboration of this study shows that similar parallelisms connect the sun spots with the rainfall, the heights of rivers, volcanic eruptions, earthquakes, and numerous other phenomena.

(20) The tenth chapter deals with the influence of the moon upon the aurora. Scarcely a single terrestrial phenomenon, but what the attempt has been made to connect it with the moon; and this is equally true of the auroras. Thus Cotte, in 1780, seemed to show that there was an excess of auroras when the moon is south of the equator as compared with the time when she was north of the equator. Dalton, in 1834, found the time of the greatest frequency of auroras to be at the time of the changes of the moon. Richardson and Franklin, in the northern part of British America, observed that the auroras were distributed less frequently in the interval between the first quarter and full moon, as compared with the latter half of the moon's orbit, in the ratio of 38 to 125. Broun, at Makerstoun, found the maximum frequency of auroras to occur between the 18th and 22d day of the moon's age. Fritz, himself, has investigated the distribution of over two thousand auroras occurring between 1842 and 1860; he finds the influence of the moon on the aurora to be very slight, and that the evidence thereof is obscured by the effect of the relative brightness of the earth as illuminated by the moon. Hoslen, 1784, made a nineteen-year series of

observations that were used by Ritter, who, in 1803, announced his conclusion that the frequency and magnitude of aurora stands in an intimate connection with the eighteen-and-two-third year period of nutation, and such that the maximum of auroras coincides with the mean inclination of the ecliptic. The agreement of Ritter's results with observations is frequently very remarkable, but on several occasions of maximum frequency his conclusion differs wholly from observation, and at present we look to the sun, rather than to the moon, as the origin of these disturbances. The great aurora period of fifty-five years is equal to three times the nutation period, 18.6 years, whereby an apparent further connection is made out.

(21) The optical phenomena of the aurora are described in Chapter 11. After speaking of the elementary matters known to all observers, Fritz concludes that the general result of previous studies has been to show that the frequency of the colors exhibited by auroras diminishes in proportion as the color is farther removed from the brightest part of the spectrum; the order of frequency being white, yellow, red, green, blue, and violet. In the auroral beams the most frequent arrangements of colors are as follows:

Upper color .....	Green.	Green.	Orange.	Purple.
Lower color .....	Yellow.	Red.	Violet.	Blue.

When a beam moves horizontally, its advancing side is red. The direction of an auroral beam seems to coincide nearly with that of the freely suspended magnetic needle; but considerable departures from this rule seems to be noticed; thus, in 1848, Kowalski, at Obdorsk, observed the beams crossing each other and passing over the zenith without forming a corona. The formation of a crown or corona is an optical phenomenon due to perspective. The dark segments and dark beams depend on the condition of the atmosphere, and are not entirely due to contrast with the bright portions of the aurora.

(22) The brightness of the aurora occasionally surpasses that of the full moon, or of the atmosphere illuminated by the moon; but of its intrinsic brightness as compared with moonlight, or the electric discharge *in vacuo* we can know nothing until we can locate the distance of the aurora from the observer. More important than the determinations of the intensity of the light are the investigations in reference to the peculiarities of the light, since from such studies we must hope to make further progress in our knowledge of the nature of the aurora. The first publication in reference to the spectrum of the aurora dates from 1868, when Angstrom announced to the scientific association at Upsala his discovery that the aurora light is monochromatic, consisting of one bright line, whose place in the spectrum is near the calcium line, and which has a wave length of 5567. Angstrom further announced that spectroscopic observations of the zodiacal light had shown him that the same line was prominent therein, and as this line is not known to be produced by the combustion of any terrestrial substance, it seems legiti-

mate to conclude an intimate connection between the aurora and zodiacal light. Similar observations have been made by Otto Struve, Winlock, Flügel, Ellery, Lindsay, Barker, Vogel, Browning, and others, who have been able with more perfect apparatus to increase the number of auroral lines and bands up to fifteen or twenty, all of them, however, much fainter than Angstrom's line, which is usually spoken of distinctively as the aurora line. Angstrom has suggested a theory according to which the apparent spectrum of the aurora consists of two different spectra superposed, one of monochromatic yellow light peculiar to the aurora; the second, identical with the spectrum of the light at the negative pole of a platinum electrode immersed in dry air rarefied to a pressure of only a few millimeters. Some observations upon the spectrum of the solar corona have led to the suggestion that the auroral light is nearly identical with that of the corona; but observations on this point are contradictory, and the conclusion is not generally accepted.

(23) The spectra of the November meteors, as observed by Browning, has considerable similarity with that of the aurora, as also has the spectrum of the lightning, from all of which it is rational to suspect that the atmosphere of the earth has an important part in determining the characteristics of the spectrum of the aurora as well as in the formation of the aurora itself; but all definite conclusions as to the origin and nature of the aurora must be withheld for the present.

(24) In the twelfth chapter Fritz exposes the present state of our knowledge as to the much debated question of the noise accompanying the aurora. The opposite views held by so many prominent observers are carefully weighed by him with the following conclusion: "This shows satisfactorily how great a part of the noises heard during the auroras depend upon self-deception; especially do the cases in which the noise and the light ought to appear simultaneously prove how very misleading the appearances are. If such observations are not the result of deception, then the noise should spread through the upper regions of the atmosphere, and distribute itself in the higher latitudes."

To substantiate his hypothesis he constructed an aurora apparatus; but in this at the two Poles he produced very different phenomena corresponding to electricity of opposite signs, so that if his apparatus corresponded to nature the northern and southern auroras ought to present very different appearances, which, however, is not the case. His apparatus therefore only imitates the outward appearance of the auroral rays, which can be made to vary in the most striking and brilliant manner by the increase or decrease of the vacuum employed in the apparatus, or by the introduction of various gases or vapors.

The hypothesis of George Fisher, London, 1834, has been widely adopted, according to which the aurora is an electric discharge between strongly electrified masses of ice or snow crystals, formed in the neighborhood of extensive fields of ice or snow, where the aqueous vapor is being most rapidly condensed; but we must still consider it an open ques-

tion whether any noise is developed in connection with the aurora. It is remarkable that in the Southern Hemisphere no one has ever noticed or recorded the least suspicion of noise during an exhibition of the aurora australis.

(25) Although a definite conclusion as to the precise nature of the aurora is not yet attainable, yet it is worth while to review the numerous hypotheses that have been suggested. We select a few from the very complete review given by Fritz. The hypothesis of an electric discharge dates from the memoir by Canton, London, 1753, and is presented in a form corresponding to our present knowledge of the electricity by De la Rive, 1865, according to whom positive electricity flows from the equator toward either Pole accompanying thunder storms. But a similar difficulty seems to beset both these explanations, in that no one can explain why the two kinds of electricity are not followed by a state of equilibrium immediately after the discharge has taken place.

Mayer, the founder of the mechanical theory of heat, has sought to explain the origin of atmospheric electricity as due principally to the friction between the ocean and the trade-winds of the tropical regions, a hypothesis that is partially supported by the observations of Secchi and others, according to whom the north and south winds have definite influences upon the position of the magnetic needle. Muncke and Moser have between them elaborated a thermo-electro-magnetic hypothesis, according to which, under the influence of the sun's heat, the rotating earth must be an electro-magnet. If the earth becomes magnetic then, in consequence of its perpetual rotation, the iron contained within the earth's crust will become permanently magnetic, and the magnetic variations, partly periodical and partly appearing as perturbations, are fairly explained. The periodical changes would be caused by the periodical changes in the relative positions of the earth, the moon, and the sun, and the variations in the radiation of heat from the sun's surface, while the extraordinary and irregular disturbances in terrestrial magnetism would be due to the disturbances and changes occurring on the sun's surface, similar to the changes perpetually occurring in the earth's atmosphere. The origin of the electricity to which the auroral light is attributable is explained by F. Mohr as due to the friction of currents of air flowing over each other in different directions, and the greater frequency of appearances in high latitudes depends on the dryness of the air. This view is also sustained by Prestel. For the great aurora of February 4, 1872, Mohr computes the total amount of air in motion, and finds an average over the whole of Europe of over one thousand million pounds of air in movement for each English mile square, so that the aurora is only an extremely small effect of an immense force. But if we attempt to extend the Mohr-Prestel theory to the observations at Spitzbergen and Franz-Josef Land, then the results appear quite different.

Balfour Stewart considers the aurora as a secondary electric current due to small but sudden changes in the earth's magnetism, produced

by unknown causes. In 1869 Silberman remarks, "All the phenomena appear as if the aurora of 1859 and 1869 were simply thunder storms, that discharged themselves not in lightnings but in steady streams towards the upper region of the atmosphere. It appears that when the globules of aqueous vapor in the lower strata of air are strongly charged with electricity, and are for any reason carried towards the upper region these globules crystalize in small ascending prisms, and that their electricity, by reason of its steady flow from these ice-needles, becomes visible as the auroral light. In this way the apparent ascension of the auroral beams is explained."

Many of the advocates of the electrical hypothesis seek for the origin of the electricity either in the earth or the ocean. But a decision thereupon is still in the distant future. Sirks, in 1873, seems to have been the first to attribute the electric currents upon the earth to the direct influence of the sun, which is the source of all forces upon this earth as well as the other planets. Baumhauer, in 1844, suggested the meteor-dust theory. According to this the higher regions of the atmosphere are full of the dust particles from innumerable meteors which become incandescent as they flow toward the magnetic poles. Similar views are maintained by Foster, Schmidt, and others. If, now, we compare the epochs at which the various theories and hypotheses have arisen, we recognize at once that with every step of progress in physics, astronomy, and chemistry, fresh impetus is given to the search for the explanation of the phenomena. The meteorite theory could only be developed lately, namely, since the doubt has been dissipated which has for a long time existed as to the cosmic origin of the falling masses, and since the meteor shower of 1833 has made us familiar with the regular recurrent November stream. Even now we have but just recognized that planetary space is full of large and small bodies which enter into the sphere of attraction of the earth and become visible as meteoric stones. (Fritz, *Das Polarlicht*, Leipzig, 1881.)

The diurnal change in magnetic declination at Greenwich has been deduced by Karlinski from the annual observations published by the Greenwich Observatory, as based on the photographic registers. The principal maximum occurs between 1 and 2 p. m., and the general diurnal change is shown by the following table:

Hour.	Departure.	Hour.	Departure.	Hour.	Departure.
6 a. m.	- 2'. 35	2 p. m.	+ 5'. 88	10 p. m.	- 2'. 03
7 a. m.	- 2'. 78	3 p. m.	+ 4'. 47	11 p. m.	- 2'. 13
8 a. m.	- 3'. 03	4 p. m.	+ 2'. 78	Midnight.	- 2'. 08
9 a. m.	- 2'. 28	5 p. m.	+ 1'. 30	1 a. m.	- 1'. 85
10 a. m.	- 0'. 03	6 p. m.	+ 0'. 18	2 a. m.	- 1'. 70
11 a. m.	+ 2'. 90	7 p. m.	- 0'. 59	3 a. m.	- 1'. 66
Noon.	+ 5'. 25	8 p. m.	- 1'. 18	4 a. m.	- 1'. 73
1 p. m.	+ 6'. 23	9 p. m.	- 1'. 71	5 a. m.	- 2'. 00

(Z. O. G. M., 1879, XVI, p. 60.)

Nahrwold has investigated the conditions under which the atmosphere can assume a charge of electricity. He used an apparatus consisting essentially of the following: A metal cylinder in which the air to be investigated can be entirely closed and removed from the influence of exterior electrified bodies. Through an aperture in the upper cover of the cylinder a filter filled with quicksilver is inserted, which is connected by a wire with the quadrant electrometer. If the air in the cylinder is electrified, and we allow the mercury to flow, the needle of the electrometer shows a deviation. The mercury acts like Thomson's water-dropping apparatus. The cover of the cylinder has one other opening through which can be successively introduced two different arrangements for electrifying the included air: first, a needle with a fine point that can be pushed in and out of a platinum tube; second, a thin, short platinum wire soldered between two copper wires: in the experiments these copper wires are connected with the battery so that the transmitted current brings the platinum wire to incandescence.

If the cylinder is filled at the window with fresh air, the electrometer put in position, the needle shoved forward, and we allow the scarcely visible spark from a feebly-charged Leyden jar to jump to the wire connected outside the cylinder with the needle, and then set the dropping apparatus at work, there is observed a sensible deviation of the electrometer. If the experiment is repeated with the intention of attaining a stronger charge, we, on the contrary, observe now a feebler deviation. This diminishes continually so long as we retain the same mass of air in the apparatus, and not only when it is electrified but also when it is allowed to stand quietly. We must seek the cause of this phenomenon in the behavior of the particles of dust. So long as the dust is circulating within the metal cylinder it rapidly carries away the electricity collected at the point of the needle; but if the dust has settled (and this is very much retarded by the electrification), then is the air freed of dust not in the condition under the given circumstances to take up a charge. If by means of a feather we stir up the dust from the sides of the cylinder, then the first subsequent experiment shows again a large deviation; if, on the other hand, we hold every particle of dust that touches the sides of the cylinder firmly there, to which end Nahrwold covers the interior of the cylinder with glycerine, then the further experiments show that the dropping apparatus takes almost no further charge.

Instead of the needle point, the incandescent platinum wire is now employed to give a charge to the included air. The battery that serves to excite the electric current requires no further consideration in this case; it, together with the conducting wire, is isolated, and the platinum wire within the cylinder can be charged from any source of static electricity. The air now takes up the electricity even if it is entirely free from dust. The air heated by contact with the glowing platinum wire becomes a good conductor of electricity; it flows away cooling down, but still retaining its charge, while other portions of the air within the cylinder become heated and charged with electricity by the platinum wire.

That this process depends principally upon the temperature to which the air is heated is evident from the fact that when the wire is of a dark red incandescence no transfer of electricity takes place; it is with the bright red glow that the air first begins to be charged. Nahrwold further concludes that the charge cannot be increased indefinitely, but approaches a maximum limit. He also observed a difference in the behavior of the air with respect to the two forms of electricity—it takes a positive charge easier than a negative one.

When two crowns, composed of thirty-four knitting needles, were placed upon the base of the apparatus by which the electricity could be conducted to the earth, it appeared that these points hastened the discharge of electricity, or the loss of the original charge only when the air was filled with dust, which further proves that the so-called influence of such points is largely dependent upon the dust contained in the air.

From a few experiments which gave a strong negative charge to the air after stirring up the dust on the floor of the room, Nahrwold concludes that the dust becomes electrified by friction, and he concludes his memoir as follows: "If the electricity of the dust depends, even only in part, upon friction, and is therefore at least in part independent of the distribution of atmospheric electricity properly so called, then in observations of atmospheric electricity this must be considered as in most cases a not unimportant source of error and must necessarily be avoided. In this condition, most difficult to fulfill, we see a new obstacle in the way of attaining a clear idea as to the electrical processes in our atmosphere, and we find ourselves no nearer the attainment of the object of our labors through the results of the present investigation.

"The method here employed is, however, certainly the least unsafe. The observations here given are in their meteorological aspects scarcely more than preliminary trials for a far more important investigation, which will ultimately lead us nearer to the object in view.

"Those conditions that most probably exercise an important influence on the electrical condition of our atmosphere must be realized on a small scale, and I hope ere long to be in the condition to again prosecute this work in this direction." (*Z. O. G. M.*, XIV, 1879, p. 72.)

Weyprecht, in the *Denkschriften* of the Vienna Academy (Vol. XXXV), gives the results of his aurora observations. He classifies the optical appearances, first, as arcs; second, as streamers; third, as rays; fourth, as corona; fifth, as haze. To these forms there is also to be added a dark, narrow, low standing arc of light, whose center coincides nearly with the magnetic meridian, and which he calls the dark segment. The movements of the auroral light are classified as follows: first, waves; second, flashes. As to the height of the aurora Weyprecht concludes that even in the arctic regions this is very variable, but much lower than in our latitudes. The appearance of the aurora is as though its light were dependent on that from some other matter. No connection can be made out between the aurora and the subsequent weather, neither can any noise be heard attending the aurora; a slight



cloudiness appears to favor the development of certain auroras. As to the connection between the magnetic perturbations and the aurora, the observations show that perturbations of the needle may take place without the auroral display, and *vice versa*, the aurora without perturbations of the needle. Those forms of aurora that present irregular outlines, no rays, and no perceptible motions, are seldom accompanied by perturbations; on the other hand those auroras that appear to have a small altitude, and to be very near to us, having definite outlines, rapid movements, and well-marked radial structure, set the needle in rapid movement. (*Z. O. G. M.*, XIV, 1879, p. 190.)

P. F. Denza has given the following laws relating to atmospheric electricity, based on twelve years' observations—six times daily—at Moncalieri: *Regular variations*.—He says the daily variations show themselves clearly in the winter and summer, having two maxima after sunset and sunrise. The yearly variations attain their maxima at the end of February, the minima in September. The annual means show no connection with sun spots or magnetic changes. *Irregular variations*.—Thunder storms affect the tension very much. Rain and snow increase the electricity. Dense fog and haze, cloudiness, etc., increase the intensity very slightly. The least electricity is shown during clear or very clear sky, and especially when it is also very warm. Southerly winds, especially southeast, increase the electricity; but during strong winds the indications of the electrometer are uncertain. During these twelve years, out of a hundred cases of rain and snow, fifty give negative and fifty positive electricity; the same ratio holds good for thunder storms and hail, whether they pass over the observer or pass by at a distance. Negative electricity occasionally is observed before and after a thunder storm, and also more rarely before and after a rain or snow. When the sky is clear or completely covered, electricity is always positive, and negative electricity occurs only under dissimilar conditions—such as distant storms, clouds, auroras, etc. An electrometer being also placed on St. Bernard, at an altitude of 2,160 meters, the comparison with observations at Moncalieri (altitude 259 meters) shows that under normal conditions the electric tension increases with the altitude. The following table gives the mean results of observations at Moncalieri:

Hourly means.		Monthly means.		Annual means.	
6 a. m.	14.86	January	18.8	1867	7.9
9 a. m.	16.38	February	20.2	1868	11.0
Noon	12.67	March	16.1	1869	12.0
3 p. m.	12.58	April	15.8	1870	8.0
6 p. m.	16.42	May	12.2	1871	8.3
9 p. m.	15.65	June	12.6	1872	19.1
Mean	15.09	July	13.7	1873	19.4
		August	12.5	1874	22.2
		September	11.6	1875	27.6
		October	13.2	1876	19.1
		November	17.3	1877	12.5
		December	17.6	1878	11.7
		Mean	15.09	Mean	15.0

(*Z. O. G. M.*, Vol. XIV, 1879, p. 484.)

Mascart has published the discussion of the observations of atmospheric electricity, recorded every two and a half minutes consecutively, since February, 1879, by means of the water-dropping apparatus and the electrometer of Sir William Thomson, as combined in the apparatus manufactured by Charpentier. The prevalence of the negative electricity in the rain clouds, followed by very strong positive electricity after the rain, appear to be important facts, as prominent in Paris as they are also known to be in England and Italy.

The average diurnal periodicity expressed in arbitrary units is shown by the following table:

Months.	Midnight.	3 a. m.	6 a. m.	9 a. m.	Midday.	3 p. m.	6 p. m.	9 p. m.	Mean.
March .....	24.7	19.2	19.1	13.6	14.5	14.9	21.2	27.1	24.7
April .....	24.0	23.7	24.0	16.0	17.0	13.3	28.5	26.0	24.0
May .....	24.5	23.3	26.0	20.7	13.8	15.4	15.4	24.5	24.5
June .....	26.7	25.5	25.4	17.6	14.6	12.0	18.4	25.0	26.7
July .....	33.3	34.5	33.7	28.8	26.7	23.6	29.3	36.1	33.3
Means .....	26.6	25.2	25.6	19.3	17.3	15.8	20.5	27.7	26.6
Mean (total) .....	26.6	25.2	24.6	15.0	12.7	9.8	13.2	26.9	26.6

The minimum at 3 p. m., and maximum at 9 p. m., as here shown, are quite at variance with observations of Quetelet, Denza, and Everett, the reasons for which remain to be investigated. (*Z. O. G. M.*, XV, 1880, p. 136.)

Sophus Tromholt, of Norway, has published the first results of the work undertaken by him with reference to auroras, which is nothing less than a general formation of a system of aurora observations for the whole of Norway, Sweden, and Denmark. The material accumulated in the first winter alone is so great that valuable results may be drawn from it. In the first place, it appears that there is scarcely an evening that one or more stations did not report auroras, although the observations occur during the years of auroral minimum; hence the author concludes that the aurora is a very local phenomenon and takes place at a very small altitude above the earth's surface. The table that shows the cases in which auroras are observed at auxiliary stations, without being observed at the central station, Bergen, affords the most striking proof of the local character of the phenomenon. The following table shows the relative frequency of auroras for the respective zones of latitude:

Zones.	Frequency.
°   °	
71 to 68 lat ..	100
68 to 65 lat ..	30.6
65 to 62 lat ..	18.2
62 to 59 lat ..	12.6
59 to 55 lat ..	7.6

A further consideration confirms the conclusion that the aurora is a very local matter, viz, that in the whole region of  $71^{\circ}$  to  $55^{\circ}$  only three nights occur on which the aurora was observed simultaneously everywhere, and is even still doubtful in these three cases, whether the same aurora was observed everywhere. (*Z. O. G. M.*, Vol. XV, 1880, p. 480.)

W. Ellis has investigated the relation between terrestrial magnetism and solar-spot frequency, using the Greenwich observations, 1840–1847, and the Greenwich photographic records by the Brooks apparatus, 1848–1877, and, comparing these with Wolf's sun-spot numbers, the intimate relation of these phenomena is more clearly shown than ever before. This is illustrated in the accompanying table, which gives the dates of the epochs of maximum and minimum declination and horizontal force:

Epoch.	Declination.	Horizontal force.	Wolf's sun spots.
Minimum.....	1844. 7	1842. 9	1842. 5
Maximum.....	1848. 1	1849. 0	1848. 1
Minimum.....	1857. 2	1855. 1	1856. 0
Maximum.....	1860. 6	1860. 2	1860. 1
Minimum.....	1867. 5	1867. 6	1867. 2
Maximum.....	1870. 8	1870. 9	1870. 6

On the average, the magnetic epochs follow the sun spots at an interval of 0.27 a year. The durations of the four periods are nearly identical for both sun spots and magnetic phenomena.

The occasional sudden outbursts of magnetic and sun-spot energy occur and continue nearly simultaneously. (*Z. O. G. M.*, XVI, 1881, p. 489.)

Lemström has developed a theory as to the origin of terrestrial magnetism based on the electric theories of Edlund, and confirms it somewhat by actual experiments. The assumption that the earth consists of a glowing hot interior, surrounded by a cooler layer 50 or 60 kilometers thick, leads to the conclusion that the magnetic forces must reside entirely in this outer layer, since glowing hot bodies cannot be magnetized. Now, geological data show that the whole exterior shell must contain about 2 per cent. of iron, or equivalent to a layer of magnetic substance 1 kilometer thick. This layer may be considered as constituting a hollow sphere at a distance of 30 kilometers below the earth's surface, and must, under the influence of a given force, exhibit a magnetic moment, the same as if it were a solid sphere. Since, now, the earth is revolving in a space full of ether, it must become magnetized the same as if it were itself at rest, but the ether turning in an opposite direction. This rotation must give rise, according to Edlund's theory of electricity, to an infinite number of elementary-induced cur-

repts, and Lemström deduces for the whole magnetic moment ( $M$ ), in the direction of the axis of the earth,

$$M = \frac{8}{3} \pi^2 (r - h)^3 \mu J$$

where  $\mu$  is the magnetic moment of a unit's mass,  $J$  is the inductive action of a unit of current,  $r$  radius of the earth,  $h$  the distance of the magnetic stratum from the limits of the atmosphere. This explanation agrees entirely with the formula of Gauss, and the discussion of it explains equally the average position of the magnetic action and its secular annual and daily variations. It is also in conformity with the accidental phenomena of magnetic storms and auroras. (*Z. O. G. M.*, XVI, 1881, p. 108.)

Denza has determined the law of diurnal variations of atmospheric electricity at Moncalieri, and by means of hourly observations on 215 days, distributed through the years 1871 and 1878. The following tables give his resulting averages (*a*) for the 215 days or a whole year, and (*b*) for the days on which no irregular disturbances took place. The analogy between this diurnal period and that of atmospheric pressure is similar to that pointed out by Neumayer. (*Z. O. G. M.*, XVI, p. 88.)

Hour.	1871-1878.		Hour.	1871-1878.	
	<i>a</i>	<i>b</i>		<i>a</i>	<i>b</i>
6 a.m. ....	20.6	18.2	6 p.m. ....	19.5	17.7
7 a.m. ....	20.2	18.7	7 p.m. ....	19.2	17.8
8 a.m. ....	20.8	19.4	8 p.m. ....	19.4	18.5
9 a.m. ....	20.3	19.6	9 p.m. ....	20.5	19.1
10 a.m. ....	19.8	19.2	10 p.m. ....	19.1	18.0
11 a.m. ....	19.1	17.2	11 p.m. ....	18.1	15.9
Noon ....	17.5	16.2	Midnight.	17.4	16.9
1 p.m. ....	15.8	15.4	1 a.m. ....	16.2	16.0
2 p.m. ....	14.8	14.1	2 a.m. ....	16.1	14.9
3 p.m. ....	14.6	14.0	3 a.m. ....	17.3	15.7
4 p.m. ....	15.5	14.3	4 a.m. ....	16.3	15.4
5 p.m. ....	15.5	15.0	5 a.m. ....	16.9	16.1

Warren De La Rue and H. W. Müller have arrived at some interesting conclusions in reference to the altitude of the aurora. They find experimentally that the least pressure under which the aurora has been seen in their experiments, is 0.38<sup>mm</sup>, corresponding to an elevation of 37 or 38 miles. The following table collects the results of their observations:

Barometric pressure.	Altitude English miles.	Radius of visibility.	Remarks.
1 x 10 <sup>-5</sup>	24	1061	No discharge observed at this degree of tenuity.
55 x 10 <sup>-5</sup>	81.5	860	The discharge was feeble and weak.
0.879	87.7	585	Maximum of brightness.
0.800	84.0	555	Feeble color.
1.000	82.9	546	Reddish tint.
1.500	80.9	529	Do.
3.000	77.4	499	Carmine.
20.660	17.4	403	Do.
62.000	12.4	336	Do.
118.700	11.6	324	Full red and carmine.

ing figures, showing the average visibility estimated on an arbitrary scale, in which 0 = unusually clear, and 5 = densest fog or haze:

Months.	Average visibility.	Total number of observed zeros.	Total number of observed fives.
January ....	2.3	12	32
February ....	2.4	7	19
March .....	2.0	19	20
April .....	1.6	23	6
May .....	2.1	9	3
June .....	2.6	2	6
July .....	2.6	8	11
August .....	2.2	8	5
September ..	2.2	6	21
October .....	2.2	12	28
November ..	2.6	4	29
December ..	2.9	3	25

On the average, Dr. Hamberg finds that the greatest clearness occurs with winds between N. and W., and the greatest obscurity with winds between S. and W.; these cases, of course, correspond to positions of the barometric minima, respectively, northeast and northwest of Upsala. A comparison of these observations with the relative humidity of the air shows that in general transparency diminishes with an increase of moisture, and especially is this the case during the colder weather. A direct dependence upon cloudiness is not evident, and the author concludes that the partial condensation of the aqueous vapor in the atmosphere and the presence of dust or smoke are the fundamental causes of the variations in transparency. Of the origin of the material composing the day fog nothing definite is known. As a means of foretelling rainy weather the transparency of the air is frequently appealed to. Hamberg finds that the quantity of rainfall increases directly as the transparency diminishes. (*Z. O. G. M.*, XVI, 1881, p. 457.)

## XII.—MISCELLANEOUS MATTERS.

(a) *Periodicities.*—S. A. Hill has investigated a decennial period in the annual variation of temperature and pressure in India. He states that the heat of the summer of 1878, especially during the first twenty-one days of June, was so great in Northern India that nothing like it had ever before been experienced. This excessive summer heat was preceded and followed by winters of unusual cold. He has therefore collected all available observations bearing upon the question of a possible periodicity in temperature and pressure. The temperature appears to follow the variations in the sun spots. He finds that at Calcutta the greatest variations in pressure occurred in the years 1845, 1857, 1866, and 1876, and the least variations in the years 1840, 1847, 1861, 1872, and 1874, and these dates are only slightly modified if we take the means of groups of three years each. The above dates agree closely with the minima and maxima of the sun spots. An explanation of this coincidence may be about as follows: The general distribution of winds on

the earth's surface depends upon the rate of diminution of temperature from the equator to the poles, and the distribution of pressure depends upon the intensity of the atmospheric currents. If, therefore, the solar radiation varies with the sun's spots, there must be a parallel variation in terrestrial temperatures and pressures. (*Z. O. G. M.*, XIV, p. 302.)

Blanford has investigated the question of a compensation between India and Russia in the variations of mean atmospheric pressure during one sun-spot cycle. Already in 1877 Eliot had called attention to the fact that, through the whole year, the pressure over India had been above the average, and that this condition extended to such distant regions as New South Wales and Victoria, Blanford having found that an excess of pressure also prevailed over the greater part of Asia, and also of the Indian Ocean. By comparison of the records from 1847 to 1862, Blanford now finds that throughout the whole of the Indo-Malayan region an oscillation of the barometric pressure existed, coinciding nearly with the sun-spot cycle. The greatest atmospheric pressure coincides, or immediately follows, the epoch of minimum frequency of sun spots, and the minimum pressure corresponds with the sun-spot maximum; or, considering the result of Köppen's investigation, the highest pressure agrees closely with the epoch of greatest mean temperature of the air. On this point he says: "In reference to the nature of the physical causes that bring about this oscillation in the pressure of the air between the Indo-Malayan region and the plains of Russia, and conforming to the sun-spot cycle, our knowledge is still much too incomplete to attempt a satisfactory analysis," (*Z. O. G. M.*, XV, 1880, p. 158.)

In the remarks on the above by Dr. J. Hann, he suggests that without more special deduction it is still quite clear that the period of increased energy in the solar radiation will also be a period of increased energy in the general currents of the earth's atmosphere. (*Z. O. G. M.*, XV, 1880, p. 161.)

Balfour Stewart in some remarks on long variations of rainfall, says: The currents in the earth's atmosphere are regulated by two considerations, of which one is a constant while the other is variable. The constant element is the time of rotation of the earth round its axis, while the possibly variable one is the intensity of the solar radiation. If, then, it is also true that we have not only a long period of variation in the intensity but also in the distribution of terrestrial atmospheric currents, and if we consider the great influence of local peculiarities upon rainfall it would be too much to expect that the annual irregularities shall everywhere attain their maxima and minima at the same time. It is perfectly possible that some places may have maximum while others have a minimum, and still others have a double instead of a simple period. We are, therefore, not yet in a position to determine experimentally the long periods of rainfall for the whole earth, since we only have as yet a few selected stations. The diversity of results obtained, by Meldrum, Rawson, and others is in accordance with the above

views. Stewart then attempts to deduce some results from observations in Europe by means of the method of indeterminate periods proposed by Dr. Dodgson and himself. He finds that there is in three stations out of four evidence of a nine-year period, and a still stronger evidence of a twelve-year period, and makes some comparisons between the corresponding ten and twelve year periods in the daily amplitude of the magnetic needle. (*Z. O. G. M.*, XV, 1880, p. 228.)

Fritz has pursued his further studies into the variations and height of the water of the river Nile, and has added to his study of the records of the Nilometer of the island of Rhodes, near Cairo, for the years 1825 to 1872, a further study of the records for the *barrages* for the years 1849 to 1878. The differences between the record at Cairo and the *barrages* are quite sensible, amounting in extreme cases to 0.71 meter. The extreme height of the river occurs on the dates shown in the following table:

Barrages.		Island of Rhodes.		Sun spots.	
Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.
			1828		
		1835	1841		
		1845	1849		1848
1857	1852	1857	1861	1856	1860
1866	1861	1866	1870	1867	1871
	1872				

Few rivers vary their regimen so regularly as the Nile, and the entire periodical change reminds one forcibly of the interpretation of the dreams, and the provisions against hunger and famine, that are attributed to Joseph, the son of Jacob. (*Z. O. G. M.*, XV, 1880, p. 302.)

In a fourth contribution to the subject of secular variations in the weather, Köppen reviews a mass of data relating to the severe winters of Europe during the past thousand years. He finds that regular laws of periodicity, although they frequently appear to obtain for several periods or centuries, yet eventually disappear and are replaced by others. It is, therefore, impossible to base any predictions upon such empirical periods, and he concludes that although he may have contributed somewhat to our knowledge of the subject, yet his best result will be the removal of any popular illusions in reference to this subject, and the prevention of others from wasting time and labor. (*Z. O. G. M.*, XVI, p. 194.)

On the subject of the connection between barometric pressure and sun-spot phenomena several contributions have been made. F. Chambers has shown (1st) that similar non-periodic variations in pressure occur throughout India and China, the epochs of maxima and minima of pressure correspond to the minima and maxima, respectively, of sun spots but fall behind these latter at intervals of six to thirty months, depending on the longitude of the station, the western stations occurring

earlier than the eastern; he also shows (2d) that extensive famines in India accompany or directly follow a maxima of pressure.

Balfour Stewart concludes that the sun's heat is most effective during a maximum of sun spots. Mr. Eaton has collected barometric records for a hundred years at London, and Archibald has shown that these give some little evidence of the same sun spot periodicity as in India, namely, a maximum of spots corresponding to a minimum of pressure. The reverse holds good for St. Petersburg. (*Z. O. G. M.*, XVI, 1881, p. 158.)

Köppen has continued his classical researches on secular periods in the weather, by extending his studies of annual mean temperatures to cover all recent data, for the years 1841 to 1875, published since the publication of his previous memoir. The resulting curves as given by Köppen show the mean temperature for the north temperate, the tropical, and south temperate zones, as well as the curve of sun-spot frequency, and lead to the following remarks: The curve for the southern hemisphere shows both a general agreement with the spot curve, and also a series of special systematic discrepancies. If we were not, according to our experience in the northern hemisphere, to entertain a decided mistrust of generalizations based on only three sun spot periods, then we might also detect a decided law in these discrepancies in the southern hemisphere. We see, namely, that while the sun-spots increase the temperature, curves in all the three zones describe the double wave in the years 1843 to 1856, the first valley in this double wave, but in the two following periods the second valleys, all preceding the spot minimum by from two to four years, give in each case the absolute minima of temperature. In the northern hemisphere the remarkable agreement of the curves for temperature and spots from 1820 to 1840 is gradually disturbed, and after 1852 entirely disappears, although the temperatures from 1867 to 1869 give indications of a return of earlier laws. The gradual rise of the temperature in the northern hemisphere for 1875 to 1878 is again in good agreement with the simultaneous diminution of the number of spots, but the succeeding abnormally cold year in Europe forces vividly upon the attention the care that must be exercised when one would use for purposes of prediction an apparent law whose rationale is as yet not understood, and to which is subject to mysterious, and therefore wholly unexpected, disturbances. (*Z. O. G. M.*, XVI, 1881, p. 149.)

Blanford, in some further remarks on sun-spot cycles, states that out of the investigations of Gautier, Stone, Köppen, and others, it results that the variation of temperature at tropical stations during the sun-spot cycles is such that the highest temperatures occur nearly always with the minimum of spots. The intensity of the solar radiation according to the results obtained by Baxendall, and those obtained by me from ten stations in India, attains its maximum simultaneously with the spot maximum. The variations of atmospheric pressure at stations



in the Indo-Malayan, region as it is now first presented to us, is such that in those regions, where the effect of the sun is most direct, the lowest atmospheric pressure coincides with the maximum of sun-spots. (*Z. O. G. M.*, XV, p. 394.)

Hildebrandson has called attention to a valuable collection of data on the variability of climate published by Ehrenheim in 1823, which gives the years of severe winters for the past twelve hundred years, and adds considerable to the data already collected by Köppen. (*Z. O. G. M.*, XV, p. 345.)

(b) *Hypsometry*.—The new hypsometric formula of Dr. Guido Grassi and its application to the reduction of barometric observations to sea level, or to the barometric computation of altitudes, forms a memoir published by the meteorological office at Rome.

Professor Grassi has studied those formulæ in which the temperature being observed at one station some hypothesis is necessary in order to approximate to the mean temperature of the column of air, and concludes that the unsatisfactory results given by the formulæ are due to errors in the hypothesis on which they are based. His new formula, which contains not only the temperature and pressure of the upper station, but also the moisture for both upper and lower stations, reads as follows:

$$a = \frac{k}{1 - \frac{3}{8}m} \cdot \frac{t}{b+t} \cdot \left\{ \sqrt{b_0(b+t) - bt - b} \right\} + C$$

in which  $a$  represents the desired height above the sea,  $b$  the barometric pressure at the station,  $b_0$  the barometric pressure at sea level,  $t$  the absolute temperature at the upper station,  $C$  the correction for gravity,  $k = 58.6588$ ,  $m = \frac{1}{2} \left( \frac{f_0}{b_0} + \frac{f}{b} \right)$  wherein  $f_0$  and  $f$  are the force of vapor in millimeters at the upper station and sea levels, and  $f_0$  can be computed by Hann's formula:

$$f_0 = f \times 10^{\frac{a}{6500}}$$

For reductions to sea level, Grassi transforms this formula in the following:

$$b_0 = b + \frac{a-C}{kt} \left( 1 - \frac{3}{8}m \right) \left\{ 2 + \frac{a-C}{kt} \left( 1 - \frac{3}{8}m \right) \frac{b+t}{b} \right\} b$$

The comparison between this formula and those given Ruhlmann and Saint-Robert shows that Ruhlmann's gives results nearer the truth if we deal with annual means; but Grassi's formula shows somewhat less of the annual periodicity. (*Z. O. G. M.*, XIV, 1879, p. 31.)

Dr. Jordan has deduced an empirical and new barometric formula for use with a barometer established at some intermediate station. He first represents the temperature for an extensive net-work of stations by a formula in which altitude and latitude occur as linear functions, and from which the average rate of diminution of temperature with

altitude can be determined. Thus for Southwestern Germany the mean annual temperatures from 1869 to 1878 give a diminution for each hundred meters of altitude, as shown in the following table:

Altitude.	Diminution of temperature per 100 feet.
<i>Meters.</i>	°
100	0.9
200	0.9
300	0.8
400	0.7
500	0.7
600	0.6
700	0.5
800	0.5
900	0.4
1,000	0.4

He then gives the constants in an empirical formula for the same portion of Europe, and finds the following:

$$h = 18517 (\log 762.56 - \log B_0) (1 + 0.003665t)$$

and shows, by means of this, that the altitude may be computed with a probable error of plus or minus 3 meters. (*Z. O. G. M.*, XV, 1880, p. 166.)

H. Feld and C. A. Vogler have put into convenient form for the computation of barometric altitudes at the latitude of  $50^\circ$ , the hypsometric formula of Ruhlmann. By introducing a graphic process they have reduced the time very materially, but with slight expense of accuracy. (*Z. O. G. M.*, XVI, 1881, p. 85.)

(c) *Biological Relations.*—Oettingen has investigated some points in the connection between meteorology and botany that are worthy the attention of other meteorologists. The principal previous workers in this field have been Boussingault, De Candolle, Gasparin, and Linsser, whose results are reviewed by Von Oettingen.

Boussingault maintained that any particular phase of development ( $x$ ), such as the time of budding, ripening, &c., should be considered as a function of  $t$ , the mean temperature, during the interval of time,  $z$ , that has elapsed since an assumed starting point, and  $u, v, w$ , &c., which represent other climatic elements.

De Candolle and Gasparin showed that  $x$  should be a function not of  $t$ , but of  $t-s$ , where  $s$  represents a minimum temperature limit, below which the development of the plant makes no progress whatever.

Linsser showed that  $x$  is a function of  $\frac{tz}{TZ}$  and  $u, v, w$ , where  $TZ$  is a constant, having a different value for each plant and each locality.

Oettingen finally proceeds to investigate the dependence of blossoming upon temperature for fifty-five plants, for which he had accurate observation at Dorpat. The general conclusions to which the author is led are as follows:

1. Certain values of the epochs of budding can be deduced with pre-

cision for various phases of many species of plants, so that the present method of investigation can be safely recommended.

2. Very improbable values of this epoch are recognized at once by large limits of error; only such normal data as correspond to the smallest probable errors have a claim upon our acceptance.

3. In the deduction of normal data the computations lead to nearly the same value for the dates of budding for all the fifty-five plants. Differences of two or three days occurred only when few observations were at hand.

4. Even in the case of fragmentary but longer series of observations, Oettingen's method of computation can be applied, and it is immaterial whether the phase under consideration occurs in the extreme coldest or warmest portion of the year.

5. The computation of a mean date from a series of observations affords opportunity for determining the variability in time or the probable error of the average date.

6. The probable error of the total sums of heat, as deduced from observations of many years, must depend upon the variability of the weather.

7. The present method of investigating the conditions of budding can perhaps be checked by experiments upon certain species that will develop in water at different temperatures. (*Z. O. G. M.*, XIV, p. 326.)

In a further review of Von Oettingen's work on this subject Karl Fritsch states that in 1857 he first compared all the formulæ that were then known with the best observations available in the development of the growth of plants and showed that the Boussingault formula has the greatest probability although it was intended especially for annuals. In 1861 he extended this work to a computation of the constants for 1,889 different species of plants, for which ten consecutive years of observation were available, the result of which showed that his method of computing his thermal constants must be very near the truth. New formulæ were, however, proposed by Tomaschek in 1862, and by Kabsch in 1863, Hoffman in 1865, Ziegler in 1867.

In 1867 and 1869 Linsser attempted a further elaboration of the subject, which, however, was not brought to a satisfactory end at the time of his death. Krassan in 1868 and Köppen in 1870 spoke against the general principle of the temperature summations; but the important work of Oettingen brings us back to the firm conclusion that the law of a constant quantity of heat is necessary to a given stage of development has a high degree of probability, and his method of determining the base temperature from which the sums are to be counted seems to be the best at present available. (*Z. O. G. M.*, XIV, p. 376.)

Hoffmann, of Giessen, has published additional confirmation of his method of determining "thermal-constants" for plants. He sums up the daily maxima of a thermometer exposed to the full sunlight from January 1, the time of the minimum of plant activity up to the date of

the occurrence of the respective botanical phases. He finds the observations of plants that blossom in early spring very irregularly affected by early frosts, but gives the following table for plants that flourish in summer and autumn. Three thermometers have been used exposed under very similar circumstances—Nos. I and II, during 1880, No. III, during the earlier period, 1866 to 1860.

The results seem very closely comparable among themselves.

Plant.	Date of first blossom, 1880.	Thermal constant for the years.		
		I.—1880.	II.—1880.	III.—1866-'69.
<i>Aesculus macrostachya</i> .....	VII. 21	3, 504	3, 191	3, 353
<i>Catalpa syriensis</i> .....	VII. 23	3, 557	3, 229	3, 318
<i>Linum catharticum</i> .....	VIII. 14	4, 091	3, 753	4, 033
<i>Mirabilis jalapa</i> .....	VII. 31	3, 776	3, 441	3, 143
<i>Plumbago europæa</i> .....	X. 5	5, 495	5, 054	5, 318
<i>Pulicaria dysenterica</i> .....	VII. 25	3, 618	3, 292	5, 381
<i>Valeriana plumbaginoides</i> .....	IX. 3	4, 767	4, 352	5, 177
<i>Vitis vinifera</i> .....	VI. 22	2, 697	2, 603	2, 606
<i>Lilium candidum</i> .....	VI. 29	2, 872	2, 603	2, 710
<i>Aster Amellus</i> .....	VIII. 14	4, 091	3, 753	3, 930

Hoffman finds evidence that this law also holds good for plants protected in greenhouses, and further, that the mean temperatures in the shade cannot have such a connection with the development of the plant as have those shown by the insolation thermometer. (*Z. O. G. M.*, XVI, 1881, pp. 331-334.)

(d) *Meteors*.—Dr. J. H. L. Flögel communicates observations by himself on particles of iron dust found in snow, and gives a summary of previous researches on this subject, beginning with Ehrenberg in 1849.

The first snowfall examined by Flögel gave in the purest melted snow water nine forms of diatoms, confervæ, spores, alive or apparently alive; fourteen forms of pollen or other parts of animals and plants; and five forms of mineral substances. The subsequent snowfall, however, beside these forms of dust, invariably gave iron, and the total amount of the latter was in one case about  $\frac{1}{1000000}$  of the volume of fresh-fallen snow.

Flögel admits that the cosmic origin of this iron dust (and Grönan's theory of the dependence of auroras upon its presence) is very plausible, but that it still needs to be proven to be of local terrestrial origin, and be specially confined to certain regions of the globe. The question will probably be best settled by investigating the presence of nickel, as, if present, it would argue irresistibly for the cosmic origin of this iron dust. (*Z. O. G. M.*, XVI, 1881, p. 321.)



## PHYSICS.

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### GENERAL.

The progress of physical science during the year 1881 has been marked, especially in the department of electricity. But so intimate are the relations which connect together the various branches of physics that this advance has required corresponding activity in all the other departments.

Stas, as *rapporteur*, on behalf of Broch, St. Claire Deville and himself, appointed by the International Committee of Weights and Measures a sub-commission on the preparation of an X-rule in platinum-iridium, has given a detailed account of the preparation of this rule by Matthey, the eminent metallurgist, to whom they had confided the work. The platinum was prepared by precipitation from the chloride, two specimens, each of 35 kilograms, being obtained and analyzed simultaneously by Deville in Paris and Stas in Brussels. Specimen A gave 99.892 platinum, 0.065 rhodium, and 0.029 iridium; specimen B 99.890 platinum, 0.070 rhodium, and 0.023 iridium. A previous alloy was used to yield the iridium, special care being taken to exclude metals other than platinum. On analysis it gave: iridium, 91.100; platinum, 8.480; rhodium, 0.122; ruthenium, 0.120, and iron 0.042. For the alloy, 18,015.65 grams of platinum, sample A, was mixed with the iridium in such proportion that 100,000 parts of the mixture should contain 1,025 parts of pure iridium; the extra 25 parts being added to supply loss in working. The finely-divided metals were sifted thoroughly together, the powder compressed and fused in a lime crucible. The cylinder thus obtained, which was 10 centimeters in diameter and 7.5 centimeters high, was forged at a white heat into a bar and rolled between polished rolls. It was then cut into small pieces, kept in fused hydro-potassium sulphate in a platinum vessel for 3 hours, washed with boiling water and with boiling hydrogen chloride. These operations were repeated three times. Before the final forging three samples for analysis were taken from different parts of the ingot. The bar, which was 45 millimeters on a side, was again put under the hammer and forged into a cylinder at one end, 42 millimeters in diameter and 128 centimeters long. This was cut off and

turned into a true cylinder 40 millimeters in diameter, and cut into three equal parts. The rest of the bar was again drawn down under the hammer till it was 25.5 millimeters on a side and 103 centimeters long, an operation lasting 14 hours. It was now put on a planing-machine and planed into the form of an X in section, this labor requiring 28 days, from six in the morning to 10 at night. The bar, which before planing had a weight of 15,500 grams, weighed only 3,584 grams afterward. On examining the three specimens cut from the ingot, their specific gravities were found to be 21.530, 21.536, 21.538, at 19°, or 21.535 as a mean; that of the pieces cut from the ends of the two rectangular rules being 21.523. The turned cylinders were then submitted, in steel molds, to blows of a hammer, each blow equivalent to a pressure of 110,000 kilograms. The first cylinder received 10 blows, and had a density of 21.554; the second received 20 blows, and its density was 21.5528; the third received 30, and was 21.5531; the mean of the three being 21.553, with a probable error of  $\pm 0.002$ . The chips removed by the planer were 21.538 before and 21.548 after melting. On analysis, after purification, the chips from the planer gave Deville: iridium, 10.1560; iron, 0.035; ruthenium, 0.017; rhodium, 0.038; platinum, 89.75. The turnings gave: iridium, 10.151; iron, 0.032. In 100 parts of the alloy there were then 10.1444 parts of iridium, or 1,018 of iridium to 9,000 of platinum; a value considerably within the tolerance allowed to Matthey. Collateral experiments showed the impracticability of drawing the bar through a templet of steel, since the quantity of iron in the alloy was thus trebled. Finally, the possibility of making separate masses of this alloy uniform in composition and density was satisfactorily established, the iridium in a third specimen differing from that in the second and first by only 0.0003. The bar now goes to MM. Bruner, for the purpose of having the meter lines transferred to it from the standard meter of the government. (*Ann. Chim. Phys.*, January, 1881, V, xxii, 120.)

Sire has described an apparatus, which he calls a devioscope, for ascertaining directly the relation which exists between the angular velocity of the earth and that of a horizon around the vertical of any place whatever. In the well-known pendulum experiment of Foucault, the apparent rotation of the plane of oscillation of the pendulum is proportional to the sine of the latitude of the place of observation, in consequence of the tendency of this plane to remain always parallel to itself. The apparatus in question consists of a fixed globe supported on a vertical steel axis carried on an iron tripod. From this support just below the sphere a semicircular arm, articulated in the center, rises to carry a system of three wheels, the diameter of each being exactly the same as that of the sphere. Two of these wheels are toothed and work into each other. One of them moves on an axis parallel, when the semicircle is in its normal position, to the axis of the sphere. The upper part of this axis carries a model of the plane of oscillation. The second wheel is fastened to an axle supported on an arm always at right

angles to the semicircular arm, the third wheel being at the other extremity of this axle, and rolling on the sphere. A graduated circle on the axis, about which the semicircular arm moves, enables it to be adjusted for any latitude. Normally the pendulum-axis is in the prolongation of the sphere-axis. On turning the sphere the third wheel rolls round its equator, rotating the plane of oscillation of the pendulum in the same time as the sphere rotates, but in the inverse direction. Turning the semicircular arm  $90^\circ$  the axis of oscillation passes through the equator and the wheel rests on the pole of the sphere; hence, when the latter rotates, the plane of oscillation does not change. In intermediate positions the change of plane is proportional to the sine of the latitude, and the rapidity of the change may be read off on a graduated circle placed beneath the pendulum model. (*J. Phys.*, September, 1881, x, 401.)

G. H. and H. Darwin communicated to the York meeting of the British Association, on behalf of a committee appointed for the measurement of the lunar disturbance of gravity, the results of their experiments thus far made. In 1879 Sir William Thomson had erected at Glasgow an apparatus consisting of a solid lead cylinder suspended by a fine brass wire five feet long from the cross-beam of the stone supports used for pendulum experiments. From the bottom of the weight a rod projected, to which was fastened a single fiber, of silk attached to the edge of a small mirror. A second fiber, also attached to the same point of the mirror, was fastened to a support near the rod, so that the mirror was supported by a bifilar suspension, such that a minute motion of the pendulum would cause considerable rotation of the mirror. A lamp and slit were arranged for the readings. But the spot of light was found to be in incessant movement, so irregular that the mean position could not be fixed within 6 inches. The authors, after seeing this arrangement, constructed, in 1880, at Cambridge, a modification of it. The pendulum, suspended by the two wires, was hung in a liquid, and an apparatus was attached to it for giving it a known but very minute displacement. They found that it was subject to a diurnal oscillation, being farthest north at 6 p. m. and farthest south at 6 a. m. It was so sensitive that it showed distinctly the slight pressure on the stone gallows exerted by the finger. Water poured on the ground tilted the whole structure over, and minute changes of temperature produced marked effects. One foot of displacement of the spot corresponded to one second of arc in the direction of the plumb-line. In 1881 a new instrument was made, in which a copper tube formed at the same time the support for the pendulum and the envelop for containing the liquid. The whole was immersed in a large mass of water, and the observations were taken from outside of the room by means of a telescope. The diurnal changes and the slow change were observed in the present case, and also periods of several days in which the pendulum was in a state of continual agi-



tation, apparently independent of any external meteorological condition. The apparatus, while quite insensible to local tremors, was extraordinarily sensitive to steady forces. A person standing in the room 16 feet distant, and then 17 feet, the difference in the yielding of the floor and the consequent tilting toward the point of pressure of the stone basement, was plainly apparent. An alteration of the plumb-line by 0.01 second was distinctly measurable. The authors draw from these results some important practical conclusions. They suggest greater precautions to protect the piers of transit instruments from changes of temperature, and to provide for the drainage of the sod round their bases. The effect of the weight of the observer's body should be guarded against. (*Nature*, November 3, 1881, xxv, 20.)

Respighi has finished his experiments to determine the intensity of gravity at the observatory of Campidoglio. He used a pendulum composed of a ball of lead  $9\frac{1}{2}$  kilograms in weight, supported by a steel wire 0.6 millimeter in diameter. Five different lengths were used, varying from 7.9 to 5.16 meters. These pendulums proved independent of the earth's rotation, and showed Foucault's phenomenon perfectly. At each oscillation the point attached to the pendulum dipped in mercury, thus making an electric contact which was recorded on a chronograph. The data obtained have not yet been fully reduced. (*Nature*, May 19, 1881, xxiv, 67.)

Mendenhall has determined the value of gravity upon the summit of Fujiyama in Japan, using a Kater's pendulum, from which one of the knife-edges, the "tail-pieces," and all of the unnecessary parts were removed, and an adjustable slide-piece fixed on the piece projecting above the knife-edge. A Negus break-circuit chronometer, a chronograph, and a portable transit instrument were also used. After the necessary corrections, the value of gravity on the summit of the mountain was found to be 9.7886. In Tokio it had been previously determined as 9.7984. From these values, taken in connection with certain data concerning the mountain, Mendenhall has sought to calculate the mean density of the earth. The result obtained, assuming the density of the mountain to be 2.12, gives 5.77 for the earth's density. As this is slightly above Bailey's value, 5.67, the author reverses his calculation, and assuming this value, calculates the density of the mountain, and finds it to be only 2.08; thus suggesting deficiency in its attraction. (*Am. J. Sci.*, February, 1881, xxi, 99.)

## MECHANICS.

### 1. *Of solids.*

Stevenson has presented to the Royal Society a paper on the influence of stress and strain on the action of physical forces. He finds that (1) after a wire has suffered permanent extension the temporary elongation produced by a load diminishes as the interval between the

time of this extension and that of applying the load becomes greater; (2) this increase of elasticity is proportionally greater for large loads; (3) it takes place equally whether the wire be loaded or unloaded in the interval; (4) its rate of increase varies with different metals; (5) the elasticity can be increased by loading and unloading several times; (6) a departure from Hooke's law always attends recent permanent extension and; (7) this departure is diminished, notably in iron, by allowing the wire to rest for some time either loaded or unloaded. The influence of electricity and of magnetism on the torsional rigidity of metals was examined, and the results showed (1) that in the case of copper and iron the torsional rigidity is temporarily decreased by the passage of a strong current; (2) that of iron is temporarily diminished by a high magnetizing force; and (3) these effects are independent of temperature changes. (*Nature*, May 19, 1881, xxiv, 70.)

Anderson has presented to a committee of the Institution of Mechanical Engineers a report on the hardening and tempering of steel, in which, after discussing the theories already proposed to account for the phenomena, he proposes a new one, suggested by Edison's experiments on platinum wire. It is a generally accepted fact that ordinary steel contains a certain quantity of occluded gases, hydrogen, nitrogen, and carbonous oxide. The new theory supposes that by the application of heat, these gases are expelled through minute fissures, which open in the steel as the fissures opened in Edison's platinum wire. Sudden cooling prevents their reabsorption, and perhaps assists, too, in the expulsion. By the loss of these gases the metal becomes harder and denser than before. If, now, the metal be expanded by gentle heating, the fissures open and reabsorption begins; the various changes which the surface undergoes, as shown by the color-changes, being exponents of the reabsorption process. Experiments are to be made by the committee to test the validity of this ingenious theory. (*Nature*, May 5, 1881, xxiv, 21.)

Ewing has devised a simple form of speed-governor for continuous motion. At the end of the vertical axis whose speed is to be controlled, is a cross-bar carrying bell-cranks at its ends. The two vertical sides of these carry balls united at top by a spring. The horizontal portions carry paddles, dipping into an annular trough of glycerin. When the speed is increased the balls separate, and the paddles being immersed deeper in the glycerin; the velocity is diminished. (*Nature*, March 17, 1881, xxiii, 473.)

Holtz has determined the modulus of elasticity of the carbon rods made by Carré and used for the electric light. The acoustic method was used, the rods being held in the middle and vibrated longitudinally by rubbing with a resined cloth. On the average the modulus was found to be about the same as that of lead; though in the thinner rods the density is greater, and so the modulus is higher. Heat developed by the friction raises the tone. (*Wiedemann's Annalen*, 1881, i, ———.)

Kidder, under Cross's direction, has determined the modulus of elasticity and the modulus of rupture of white spruce wood (*abies alba*). The pieces were about  $1\frac{1}{2}$  inches square and 4 feet long. The modulus of elasticity was found to be from 1,600,000 pounds to 1,700,000 pounds, depending on the length of time the load was applied, and the modulus of rupture 11,000 pounds. (*Proc. Am. Acad.*, February, 1881, — 235.)

De la Bastie has communicated to the French Academy some results obtained by Thomasset, showing the resistance to flexure of his hardened glass. Two series of results are given. The first, including 32 tests, shows (1) that the elasticity is more than doubled by hardening; (2) that single glass hardened has 2.5 times the resistance of ordinary double glass, and (3) that semi-double hardened glass is 3.1 times more resistant than ordinary double glass. The second shows that (1) the flexure of ordinary glass is inappreciable, while the hardened glass bends under the strain; (2) that hardened glass polished, varying in thickness from 6 millimeters to 13 millimeters, had 3.07 times the resistance of ordinary plate of the same thickness, and (3) that unpolished hardened glass resists 5.33 times better than unhardened glass. (*Ann. Chim. Phys.*, June, 1881. V, xxiii, 286.)

C. O. Thompson has investigated the apparent lubricating action of salt as used in wire-drawing, and reaches the conclusion that it is a physical rather than a chemical one, a continuous, adhesive, transparent coating of salt appearing on the wire as it emerges from the draw-plate. The immense pressure to which the wire and the salt are subjected and the high temperature caused by this pressure (a temperature at least as high as the fusing point of tin,  $237^{\circ}\text{C.}$ ) cause the particles of salt to run together and to form a complete plastic coherent sheath around the wire. This result the author compares to regelation, a theory tested and proved by submitting salt on the end of a steel cylinder a half inch in diameter to a pressure of 192,000 pounds. During the first experiment a thin, transparent sheet of salt gushed from the side. After the second a transparent, coherent wafer of salt was obtained, through which the mark of a No. 4 Faber pencil could be read distinctly. (*Proc. Inst. Min. Eng.*, February, 1881. ix, 299.)

Spryng has submitted various substances to pressures up to 10,000 atmospheres, and finds that many weld completely and become crystalline. Thus bismuth becomes crystalline under a pressure of 6,000 atmospheres, and zinc of 5,000 at a temperature of  $130^{\circ}\text{C.}$  Octohedral sulphur welds easily at 5,000 atmospheres, and becomes crystalline; prismatic and soft sulphur rapidly becoming octohedral. Manganese dioxide, at 5,000 atmospheres, gives a black mass having the crystalline texture of pyrolusite. Zinc sulphide takes a saccharoid structure like sphalerite, and lead sulphide, at 6,000 atmospheres, resembles galena. A mixture of copper filings and sulphur becomes crystallized sulphide.

Crystalline salts weld with remarkable facility, giving compact, transparent masses. Coal at 6,000 atmospheres forms a solid brilliant block, easily molded. Wax at 700 atmospheres flows like water. Paraffin requires 2,000 atmospheres. Gum arabic is plastic at 5,000 atmospheres, and sealing-wax shows this effect still more markedly. (*Ann. Chim. Phys.*, February, 1881, V, xxii, 170.)

## 2. Of liquids.

Bjerknes exhibited at the Paris Electrical Exhibition an ingenious set of apparatus for showing the fundamental phenomena of electricity and magnetism by the analogous ones of hydrodynamics. The fact that a vibrating body attracts light objects near it has long been known, and the explanation that the air is rarefied by the agitation, the pressure is greater at a distance, and the light stationary body is pressed toward the vibrating one, was given in 1867 by Sir William Thomson. By means of two small pumps pulses of compression or rarefaction may be produced in drums or spheres of elastic material immersed in water, or these may be caused themselves to vibrate. If two drums are used, and both contract and expand together, there is attraction, while if one contracts and the other expands there is repulsion. But if two spheres be made to oscillate so that they move in the same direction at the same time, then there is repulsion between them. If they move in opposite directions there is attraction. The author considers the water in his trough as the analogue of Faraday's medium, and the results which he has obtained with his apparatus are very striking. (*J. Phys.*, December, 1881, x, 509; *Nature*, August 18, 1881, xxiv, 360.)

Volkman has pointed out that in the determination of the specific gravity of heavy liquids, as mercury, by means of the pycnometer, an error is introduced by the deformation of the bottle by the pressure within. In the case of a bottle provided with a capillary tube divided equally, he found that on filling it with mercury the top of the column stood at 68.1 divisions when the whole was immersed in mercury to the same level; but on removing it the column fell to 65.4. Taking the precaution to eliminate this source of error, a new determination of the value of the density of mercury gave the number  $13.5953 \pm .0001$ . (*Nature*, July 28, 1881, xxiv, 294.)

Plateau has communicated to the Belgian Academy some interesting experiments with liquid films. A piece of fine iron wire is bent so as to represent in outline a six-petaled flower; it is then dipped for a moment in nitric acid and washed, and then dipped in glyceric solution and placed under a bell-jar, and near a window. A pretty play of bright colors is observed, which continues for hours. To prove the contraction of such a film when it breaks, a bubble 11 centimeters in diameter is blown with glyceric liquid by tobacco smoke and placed on a ring. If

the top be broken when it becomes blue the mass of smoke is shot vertically upward and then spreads out horizontally. (*Nature*, October 20, 1881, xxiv, 593.)

Oberbeck has experimented to ascertain the truth of the distinction made by Plateau between the surface viscosity and the internal viscosity of liquids. He finds that with distilled water the resistance increases suddenly, and to quite considerable extent, whenever the upper edge of the plate comes into the free surface, and he does not doubt that this is due to increased friction in the surface layer. In pure water this increase of resistance was 60.9 per cent., and in salt solutions from 54.1 to 75.1 per cent. In alcohol there was a decrease of 11.9, in oil of turpentine 12.6, and carbon disulphide of 26.3 per cent. (*Wiedemann's Annalen*, 1880, II, xi, 634.)

De Romilly has contrived a very effective form of centrifugal pump, by which, even by hand, water may be raised to a height of 150 meters. Several forms of it are figured in his paper, and an ingenious application of the same principle is made use of to keep the pivots oiled. (*J. Phys.*, July, 1881, x, 303.)

### 3. Of gases.

Crookes has presented a paper to the Royal Society on the viscosity of gases at high exhaustions. Maxwell had come to the theoretical conclusion, in 1859, that the coefficient of friction or the viscosity of a gas should be independent of its density; and this conclusion he subsequently found to be true experimentally for pressures between 30 inches and 0.5 inch, the coefficient of friction in air being practically constant. Crookes has sought to extend these experiments by testing the question at much higher exhaustions than had before been used. His apparatus consisted of a globe with a long neck within which was a light plate of mica suspended by a fine fiber of glass. By means of a mirror on the fiber the oscillations of the plate could be read with the usual lamp-stand and scale. He finds that the logarithmic decrement of the oscillation is sensibly the same until the pressure reaches 3 millimeters, when there is a rapid and marked change in its value, continuing to the highest exhaustion obtained, 0.02 M, or one fifty millionth of an atmosphere. The author regards this as additional proof of the existence of the fourth or ultra-gaseous state of matter. (*Phil. Trans.*, February, 1881, Part II, p. 387.)

Sprengel has pointed out the fact that in his paper published in the *Journal of the Chemical Society* in January, 1865, he distinctly described the water-air pump. He sent a copy of this paper to Bunsen, who, three years later, printed his paper on the washing of precipitates, in which the water-pump was described. He alludes to the matter thus: "I employ a water-air pump constructed of glass on the principle of Sprengel's mercury-air pump." From this statement the name

Bunsen pump has originated; erroneously as it appears to Sprengel himself. (*Nature*, May 19, 1881, xxiv, 53.)

Rood has continued his investigations on the mercury pump, and has further perfected it, so that he has now obtained vacua of  $\frac{1}{1000000}$  of an atmosphere. The form of pump used is Sprengel's, with considerable modification in its details, not intelligible without the figures which accompany the paper. The vacua were measured with the McLeod gauge, specially modified for the purpose. The greatest care was taken in annealing all the glass, and during action the pump was warmed with a Bunsen burner. The leakage was so small that in a year it would amount to only 2.877 cubic millimeters under the normal air pressure (*Am. J. Sci.*, August, 1881, iii, 90.)

Angot has described a new and simple registering barometer, constructed by Richard frères. Six or eight holosteric barometer-boxes, so attached that their changes are added, serve to measure the varying air pressure. The upper box acts on the short arm of a lever, the long arm of which makes the record on a revolving cylinder. The arms of the lever are adjusted so that the motion of the end of the longer corresponds exactly to the variation of the mercurial barometer. On the cylinder is a sheet of paper properly divided. The rotation is effected by clock-work, so that the cylinder revolves once in seven days. A pen containing glycerin ink, being attached to the lever-arm, inscribes the curve on the paper. A metallic thermometer, recording similarly, has also been constructed, and a hygrometer is projected. (*J. Phys.*, August, 1881, x, 363.)

#### ACOUSTICS.

Cross has observed that under certain circumstances sound is emitted from a Crookes tube in action. Using the tube in which a piece of platinum is heated by the impact of the molecules shot out from the concave negative pole, a clear and quite musical note was heard. It was at first supposed to be due to the circuit-breaker; but it did not coincide with this in pitch, and changes in the rapidity of vibration of the latter did not affect the note. The effect seemed to be produced by the vibration of the sheet platinum in its own period under the influence of the molecular blows. The sound resembled somewhat the pattering of rain against a window-pane, but it was higher in pitch and more musical. The reversing of the current changed entirely its character. The sound was heard also in the mean free-path tube, best when the middle plate was positive, and in a tube containing calcium sulphide for phosphorescence. (*Proc. Am. Acad.*, November, 1881; *Nature*, May 12, 1881, xxiv, 45.)

Cook has proposed the name sonorescence for the phenomena of the conversion of intermittent light into sound, discovered by Graham Bell. Obviously this was suggested by the analogy of the word with fluorescence, given by Stokes to the change of ultra-violet rays into

luminous ones, and calorescence, applied by Tyndall to the conversion of ultra-red rays into luminous ones—the term calcescence having been previously proposed by Akin. The word sonorescence, however, to make the analogy exact, should be taken to signify the conversion of sound into luminous rays, and not the reverse effect, for which it is proposed. (*Nature*, May 19, 1881, xxiv.)

Martini has determined the velocity of sound in chlorine gas by means of a resonant column. A glass tube 0.4 meter long and 2 centimeters diameter, fixed vertically, communicated below by means of a rubber tube, with a second vertical tube adjustable in height, the bend containing sulphuric acid. When this second tube was raised or lowered the length of the column of gas could be varied so as to reinforce a certain fixed tone. The first tube being graduated, the length of the column was easily found, and a simple calculation gave the velocity. After verifying the method with carbon dioxide, and hyponitrous oxide, the author found 206.4 meters as the velocity of sound in chlorine at zero. (*Nature*, 67, May 19, 1881, xxiv.)

Robinson has described an experiment which he claims as proof that a sound wave can be polarized. An L-shaped tube 1 inch in diameter and 3 inches in length, made of tin, had a portion of the joint removed and a piece of membrane, making equal angles with the two branches, put in its place. This angle was obtained from the optical principle that the tangent of the polarizing angle is equal to the ratio of the velocities in the two media; in the present case, to the ratio 1420 : 1125, the velocities in coal gas and air respectively. A series of these bent tubes were connected together so that by turning them round each other the membranes could be placed either all parallel to each other or all perpendicular. At the two ends were membranes closing the tubes. After filling the tube with coal gas, it was found that no effect could be obtained with sound itself. A pulse was therefore produced by the fall of a ball suspended by a thread against the end membrane, the reception of the pulse being recorded by the motion of a similar ball at the other end. In one series of eighty experiments the mean deflection when the tubes were parallel was 6.47, and when perpendicular 5.43, a difference of 16.1 per cent. No difference was observed when the tube was filled with air. Conceding this result to be actual, it would seem more probable that it is due to some mechanical peculiarity of the apparatus rather than to the polarization of a longitudinal wave. But the more sweeping conclusion of the author, that all vibrations in extended media are longitudinal, and become transversal when polarization takes place, cannot at all be conceded on the basis of the experiments which he has made. (*J. Frank. Inst.*, March, 1881, III, lxxxi, 201; *Am. J. Sci.*, June, 1881, III, xxi, 501.)

Reuleaux has recorded a singular case of the production of sound by natural causes, observed while hunting in the Röderbacherthal, near

the highest part of the Rhine province. The ground is gently undulating and densely wooded. The valley, spacious on the eastern side, narrows rapidly at one part to a sort of pass, through which, for about a kilometer, the Röderbach flows westward. A southwest wind was blowing, and Reuleaux, coming along the hillside from the east, heard what appeared to be the strokes of a fine, deep-toned bell, in rapid succession. There was no such bell in the neighborhood, and some other sounds heard soon afterward satisfied him that the effects were of natural origin. Tones were heard growing in force to a maximum, then dying away; they were like those of organ-pipes at first, but their "clang" came to resemble that of a harp or violin. At the mouth of the pass, whence the sounds seemed to radiate, there was a strange agitation in the air and mixtures of sounds, some of which abruptly stopped. Reuleaux supposes bodies of air in vortical motion to have been carried along from the pass, and the sound to have been due to conflict between the outer and the inner air at the mouth of such *trombes*, producing oscillations. There was a marked difference of temperature between the higher and the lower parts of the valley, and this is regarded as an important factor in the case; the cold air above pressing on the warm below and closing the pass to a sort of tube. The wind seemed to be active only in the lower parts. (*Proc. Nat. Hist. Soc. Rheinl. & Westphal*; *Nature*, October, 1881, xxiv, 592.)

Kohlrausch has investigated the production of sounds by a limited number of vibrations. A strip of wood 3 meters long had one end fastened to the ceiling, the other carrying a weight of 6 kilograms, the whole forming a pendulum. A metallic arc, whose center was the point of suspension, was attached below, pierced with equidistant holes, in which teeth are solidly fixed. Beneath this a card is fixed carried by a piece of wood. When raised it is struck by the teeth in passing, thus producing a series of impulses varying in time with the distance of the teeth and the velocity of the pendulum, but in number determined by the number of teeth. The velocity of the pendulum was measured by a chronoscope. The pitch of the sound was fixed by a monocord, the bridge being placed at first so that the sound of the cord was evidently more acute, then more grave, than that of the pendulum. The inverse ratio of the two lengths of the cord measures the characteristic interval of height for the sound considered, *i. e.*, the difference of height which permits two sounds near to one another to be distinguished. The author's results approximately verify Helmholtz's theory of audition. A sound can be distinguished from another which makes two vibrations, more or less, if the interval of the two sounds is not smaller than  $\frac{2}{3}$ . Sixteen vibrations were found to be sufficient to determine the pitch of a sound. The method, however, does not claim great delicacy. (*Wied. Ann.*, 1880, x, 1; *J. Phys.*, May, 1881, x, 213.)

Montigny has studied the effect of liquids upon the vibration of bells, the liquids being either within or without them. He finds that (1) the



sound was lowered in pitch, (2) it was more decided the more dense the liquid, (3) it was much more marked when the bell was wholly immersed in the liquid than when the liquid was simply contained in the bell, and (4) in both cases acute sounds were less lowered than grave ones. The lowering of the sound was more decided with water than with alcohol and ether. (*Nature*, January 20, 1881, xxiii, 278.)

Ellis has presented a paper to the Royal Society on the influence of temperature on the musical pitch of harmonium reeds, giving the results of experiments on the harmonium reeds of Appunn's treble tonometer at South Kensington Museum, at temperatures differing by from  $20^{\circ}$  to  $26^{\circ}$  F: These experiments make it probable that the pitch of such reeds is affected by temperature to twice the extent of tuning-forks and in the same direction; that is, they are flattened by heat and sharpened by cold about one vibration in 10,000 per second for each degree Fahrenheit. (*Nature*, February, 1881, xxiii, 379.)

Roig and Torres have substituted for the metallic diaphragm of the phonograph a mica plate quite free at the border and supported at the center by an axis of caoutchouc fixed to a small spring. Besides the short style for indenting the tinfoil, this axis carries a piece of metal which supports a second style perpendicular to the first, the vibrations of which are inscribed on a smoked cylinder. By clockwork the same angular velocity is imparted to both cylinders, so that while the short style makes its usual marks on the tin foil the long one produces a larger tracing on the smoked surface. In these traces the authors have succeeded in recognizing the vowels, some consonants, and even some syllables, but they have not been able to read entire phrases. (*Nature*, February, 1881, xxiii, 373.)

Koenig has studied the beats and beat-tones of harmonic intervals, and concludes against the view of Helmholtz, that these are due to harmonic tones of the lower primary sounding with the higher. He has produced the phenomena by means of a "wave siren," consisting of a rotating disk or cylinder, the border of which is cut so as to represent with great accuracy the curve produced by the combination of two simple tones. When a blast of air is directed against this serrated edge through a slit, an air motion is produced quite like that produced by the two tones sounded together, and in which the beats and beat-tones are heard. When the border is a simple harmonic curve and the slit at right angles to it, a simple tone only is heard; but if this slit is slanted a little a "clang" is at once developed with strong overtones. On Helmholtz's supposition, the beat-tone obtained with two simple tones, the slits being at right angles, should be less distinct than when the overtones are brought out by slanting the slits; whereas in point of fact the precise reverse of this is the case. (*Wied. Ann.*, 1881, II, xii, 335; *Nature*, April, 1881, xxiii, 616, August, 1881, xxiv, 358.)

Koenig has described a simple and very efficient lecture apparatus

for producing beat-tones. It consists of two glass rods or tubes of different lengths clamped vertically at their centers to a jointed frame. By means of an elastic band their lower ends are pressed against the periphery of a wheel covered with cloth and dipping into water. The longitudinal vibration produced when the wheel is turned is strong and the beat-tones are very distinct. (*Wied. Ann.*, 1881, II, xii, 350.)

Maschke has devised a simple form of apparatus for showing the nodal points in tubes. A wooden graduated scale has a groove along its upper surface, on which is placed a glass tube. At one end a small steel rod is supported which enters the tube and carries at its extremity a ring covered with a membrane. Against this hangs a small ball of shellac, suspended by a silk fiber from the upper edge of the ring. If the air within the tube be vibrated by any suitable means, as by a tuning-fork, the ball is thrown into vibration, if placed at a loop, but remains at rest when at a node. The effects may be projected on a screen. (*Wied. Ann.*, 1881, II, xiii, 204.)

Koenig has also contrived a method for exploring the interior of organ-pipes while in action without interfering with their operation. The pipe used has a front of plate glass, graduated, and a longitudinal slit at the back. It is placed horizontally in a trough so that the slit and half of the back are below the surface of the water which it contains. A thin brass tube bent twice at right angles is supported so that one end enters the slit to about the middle of the pipe. It can be slid along the pipe, and is connected by a rubber tube either with the ear or a monometric flame capsule. When the inner end of the tube passes a ventral segment in the pipe a sudden weakening of the sound is noticed, and then a sudden strengthening. In this way the position of the nodes and segments can be exactly ascertained. The results are not in exact accord with theory. (*Wied. Ann.*, 1881, II, xiii, 569.)

Lovering has discovered a paper communicated to the American Academy by Nathaniel Bowditch in 1815, in which he investigates the figures made by a double pendulum which compounded two vibrations at right angles with one another. The text is illustrated by several plates of figures, which prove clearly the anticipation of the figures given by Lissajous in 1857. The ratios investigated were unison, octave, twelfth, and the double octave. (*Proc. Am. Acad.*, ———.)

Crova has described an apparatus for recording Lissajous's curves mechanically. It consists of a pendulum of wire with a heavy weight suspended from the ceiling and carrying a brush dipped in ink. Beneath this is a curved table attached to the top of a second pendulum formed of a rod, vibrating on knife-edges in a plane at right angles to the first, and carrying an adjustable weight below. The apparatus used by Crova has an upper pendulum 6.7 meters long vibrating in 2.6 seconds, and the figures are inscribed in a square 0.25 meter on a side. By burning a thread which holds the upper pendulum at any particular phase, the resultant curve is described on the paper covering the curved table. (*J. Phys.*, May, 1881, x, 211.)

Corva has also suggested the use of a magnet brought near to the forks, giving Lissajous's figures by projection, for the purpose of varying at will the differences of phase. He uses Mercadier's diapasons mounted on Duboscq's universal support. To vary the period of one of these he employs a supplementary electromagnet placed between the arms of the fork, and adjustable by a screw in a plane perpendicular to that of the branches. (*J. Phys.*, June, 1881, x, 253.)

Koenig has devised an ingenious apparatus for determining with great precision the vibrations of a normal fork. A clock-work movement of great nicety so acts on a fork making 128 vibrations as to keep it in vibration, while at the same time the fork acts as the escapement of the clock. By comparison with a chronometer the rate of the clock, and hence the error of the fork, is ascertained. If, for example, the error of the clock is  $\pm 1$  second per hour, then the error of the fork is  $\pm \frac{128}{3600}$ , or 0.0355. One of the arms of the fork carries a microscope and the other a steel mirror as counterweight. In this way the movement of the fork can be compared with that of any other vibrating body, by the optical method. The apparatus is regulated for  $20^{\circ}$  C., and the variation from  $19^{\circ}$  to  $20^{\circ}$  causes a change of 0.0143 vibration. Within a range of  $5^{\circ}$  to  $30^{\circ}$  the mean variation per degree centigrade is 0.059 to 0.054 vibration. Koenig's C<sub>3</sub> fork makes at  $20^{\circ}$  512.3548 vibrations, and at  $26.2^{\circ}$  512 vibrations. The normal French fork, correct at  $15^{\circ}$ , varies 0.0972 vibration per degree centigrade. The normal fork of the conservatory makes 870.9 vibrations at  $15^{\circ}$ , and is correct at 870 vibrations at  $27.2^{\circ}$ . (*Wied. Ann.*, 1880, ix, 394; *J. Phys.*, May 1881, x, 214.)

#### HEAT.

##### 1. *Thermometry and production of heat.*

Russell has given a detailed account of the method of Neumann for calibrating thermometers, which, he says, has very considerable advantages over the methods in common use, and which combines the greatest simplicity, elegance, and exactness. The columns measured should be as nearly as possible equal in length to a whole number of intervals between the points for which the corrections are required, i. e., for every ten degrees the required columns must be about 10, 20, 30 degrees, etc. The columns obtained are to be measured with their lower ends near all the points for which corrections are required. The method of detaching a suitable column and the details of the method of calibration are given at length in Russell's paper. (*Am. J. Sci.*, May, 1881, III, xxi, 373.)

Pernet has examined thermometers to ascertain whether the distance between the boiling point and the freezing point remains constant at all different stages of secular alteration in volume of the bulbs. He finds that it does remain constant, provided the freezing point is determined immediately after the boiling point. On the other hand, if the

boiling point be determined, and a long interval elapses before the zero is determined, there is considerable error. If a thermometer is in any particular molecular state, its reading will probably be in error, the amount of which may be ascertained by placing it in ice and observing the error of the zero reading. In order that a thermometer should read correctly at any particular temperature, it should be exposed for a considerable time to the temperature for which exact measure is desired or else for a few minutes to a slightly higher temperature. (*J. Phys.*, December, 1881, x, 520; *Nature*, July 28, 1881, xxiv, 294.)

Tait has made an elaborate investigation of the errors caused by pressure in the deep-sea thermometers of the Challenger expedition. They were all registering thermometers of the Six pattern, the large bulb being protected by an exterior shell of glass strong enough to resist the pressure of at least 5,000 fathoms of sea water, or about six tons weight per square inch, and filled with alcohol. The correction assigned to them by Captain Davis, of the admiralty, was half a degree Fahrenheit for every mile of depth. The first result reached was that this correction needed was not due directly to the pressure, but probably to the increased temperature produced by the compression. Calculation showed that the internal capacity of a glass tube with thick walls is reduced by about one-thousandth part for each ton weight of pressure. Hence if such a tube be partly filled with mercury with an index above it, the index should be displaced by one-thousandth of the length of the column of mercury for each ton weight of pressure applied to the outside of the tube. On testing the question with a thermometer tube, the mercury column being a meter long, the index was found to be displaced a millimeter for each ton of pressure. The apparatus employed for producing the pressures under which the tests were made, of 11 or 12 tons per square inch, is described, but the final results have not yet appeared. (*Nature*, November, 1881, xxv, 90.)

Waldo has examined with care three standard thermometers constructed for him at the Kew observatory. He concludes that between  $0^{\circ}$  and  $100^{\circ}$  C, the errors of these thermometers depending on the calibration, are practically insensible. Direct examination of every degree to detect accidental errors of graduation, requiring about 2,300 separate micrometer readings, shows that no sensible accidental errors have been introduced into the graduations of these standards. The corrections required at the freezing and the boiling points were found to be, as a maximum,  $+0.38$  at the freezing and  $+0.22$  at the boiling point of a Fahrenheit degree. (*Am. J. Sci.*, iii, xxi, 57, 1881.) Waldo has also suggested two slight changes in the construction of the Kew standard thermometers. As now made the capillary space is continued above the calibrating chamber. As this causes serious inconvenience from the lodgment of mercury in it, which is dislodged with great difficulty, the suggestion is that the bulb extend to the end of the cavity. Since it is often desirable to hang these thermometers up, it is convenient to

have the upper extremity of the tube turned into a ring with its plane parallel to the enameling in the tube. It is desirable further to have the kind of glass and the date of filling engraved on the tube. (*Nature*, June, 1881, xxiv, 100.)

Marey has contrived a new continuous registering thermometer for recording the temperature of the body. It consists of a closed brass tube containing oil and communicating with a Bourdon manometer. Any change of temperature by altering the internal pressure makes the curve of the manometer increase or decrease, thus registering the change by means of an index on a revolving cylinder. The thermometric bulb may be at a distance from the recording apparatus, the two being connected by a tube of annealed copper. Two such bulbs may be employed and applied to different parts of the body, exterior or interior. (*Nature*, July 28, 1881, xxiv, 294.)

Brown has devised a modification of the mercurial thermometer by which temperatures may be electrically registered at a distance. It was invented for the purpose of ascertaining the temperature of kilns for drying malt, and works well in practice. An ordinary thermometer 9 inches long with a large bulb and wide stem has platinum wires inserted through the walls of the stem every three degrees from  $120^{\circ}$  to  $171^{\circ}$  F., their outer ends being connected with binding screws. The bore of the tube above the mercury contains glycerin. Another wire of platinum passes through the bulb and communicates with the mercury. Its outer end is attached to a binding post by which connection is made with one pole of a Leclanché battery of two cells, the other pole being grounded. Near the thermometer is placed a transmitter consisting of an ebonite ring through which platinum wires pass at equal distances, their upper ends flush with the surface. An arm revolving by clock-work, and started by an electro-magnet, touches each of these wires in succession. As they are severally connected with the thermometer wires the circuit is closed by those wires with which the mercury is in contact, and a signal is sent down the line, with which the moving arm is connected, and which may be of any length. By closing the circuit of a second line wire, the electro-magnet starts the clock-work, and the traversing arm completes the circuit through a bell as many times as there are wires immersed in the mercury. This number multiplied by three and the sum added to  $120^{\circ}$  gives the temperature. (*Nature*, March, 1881, xxiii, 464.)

Langley has given the following calculation: A sunbeam one square centimeter in section is found in the clear sky of the Allegheny Mountains to bring to the earth in one minute enough heat to warm one gram of water by  $1^{\circ}$  C. It would, therefore, if concentrated upon a film of water one five-hundredth of a millimeter thick, one millimeter wide, and ten millimeters long, raise it  $83\frac{1}{2}^{\circ}$  in one second, provided all the heat could be maintained. And since the specific heat of platinum is

only 0.0032, a strip of platinum of the same dimensions would, on a similar supposition, be warmed in one second to  $2,603^{\circ}\text{C.}$ , a temperature sufficient to melt it. (*Proc. Am. Acad.*, January, 1881, xvi, 342; *Nature*, July, 1881, xxiv, 294.)

Siemens, in a lecture at Glasgow, has considered the question of gas and electricity as heating agents. The object which he set before himself was to prove that, for all ordinary purposes of heating and melting, gaseous fuel should be resorted to, for the double reason of producing the utmost economy, and of doing away with the bugbear of the present day, the smoke nuisance; but that for the attainment of extreme degrees of heat the electric arc possesses advantages unrivaled by any other source of heat. In support of the economy of gaseous fuel, he found that under the boiler of the steam-engine only 1,282 units of heat were obtained from one pound of coal, instead of 10,500, and in the melting of steel only 1,800 heat units are obtained from 2.5 pounds of coke, instead of 32,625 units, the actual value. In domestic use the waste is even greater, but it is not possible to determine it exactly. This waste led him to devise his smokeless grate, in which a fire of coke is fed with coal-gas. His office was perfectly warmed by the consumption of 62 cubic feet of gas, and 22 pounds of coke per day of nine hours, at a cost of 47 pence. The use of gas for heating is greatly to be encouraged. The electric furnace for melting steel was exhibited, and eight pounds of files were melted and poured into an ingot before the audience. A current of 70 ampères, produced by an expenditure of 7-horse power, and which would give a light of 12,000 candles, sufficed to raise an 8-inch crucible to a white heat in fifteen minutes, and in a second fifteen minutes to fuse four pounds of steel. (*Nature*, February, 1881, xxiii, 327, 351.)

Terquem has studied the constitution of the Bunsen flame, and has suggested some modifications in the form of the lamp. The ordinary flame has a hollow cone in the center, so that its heating effect is much reduced. If more air be admitted for the purpose of remedying this defect, the flame becomes solid, but very unsteady, and soon strikes down within the tube. The author has succeeded (1) in making the flame less unsteady, (2) in mixing with the gas the maximum quantity of air that the gas requires, without lighting below, and (3) in obtaining this result with tubes of all diameters up to 4 centimeters, whatever be the pressure of the gas. These objects are obtained: 1st, by dividing the opening whence the gas issues into several sectors, by two or more vertical partitions fixed on the sides and passing into the tube; and, 2d, by placing in the center of the tube a small plate or a ball which thus makes the orifice annular. The flame is thus made solid throughout, is very hot, and the tube can be raised for a decimeter above the gas-jet without having the flame strike down through it. (*J. Phys.*, March, 1881, x, 119.)

Rowland has presented a memoir to the American Academy on the mechanical equivalent of heat, with subsidiary researches on the mercury thermometer as compared with the air thermometer, and on the variation of the specific heat of water. By means of an apparatus contrived for the purpose, the various mercury thermometers to be afterward employed were compared with each other and with the air thermometer. The nature of the glass was found to have a sensible influence on the graduation of the mercury thermometer, and the differences between the mercury and the air thermometers, even between  $0^{\circ}$  and  $100^{\circ}$ , are by no means negligible, being some tenths of a degree in the vicinity of  $45^{\circ}$ . For determining the mechanical equivalent of heat, Joule's method, revolving paddles in water, was employed. A vertical axis carrying the paddles was driven by a petroleum motor, the vanes themselves moving in a water calorimeter. The work done by the friction was measured by the thermometer; that expended by the product of the number of rotations into the moment of the couple necessary to prevent the freely suspended calorimeter from turning on its axis. The number of rotations was recorded on the chronograph; and upon the same paper an electric contact recorded the instant when the mercury column reached a given division of the scale. After suitable reductions and corrections, Rowland finds that the mechanical equivalent of heat is a function of the temperature, being 429.8 at  $5^{\circ}$ , 427.4 at  $15^{\circ}$ , 426.4 at  $20^{\circ}$ , 425.6 at  $30^{\circ}$ , and 425.8 at  $36^{\circ}$ . This result the author ascribes to a diminution of the capacity of water for heat, the specific heat diminishing as the temperature increases. (*Proc. Am. Acad.*, 1879, p. 75; *J. Phys.*, January, 1881, x, 82.)

## 2. Expansion and change of state.

De Lucchi has determined the expansion-coefficient of sodium from the density obtained in petroleum at various temperatures. The sodium was cast into a cylinder under naphtha, and before solidification a fine iron wire was inserted in it, by which it was suspended to the balance. The coefficient of expansion of the petroleum oil used having been determined with great care, that of the sodium was obtained by weighing it first in the cold liquid and then in the same liquid at the required temperature. From the data thus given the relative and absolute coefficients were readily calculated. The mean coefficient between  $0^{\circ}$  and  $90^{\circ}$  was found to be 0.0002367. The absolute coefficient increases rapidly with the temperature, being 0.00014178 at  $0^{\circ}$ , 0.00016570 at  $20^{\circ}$ , 0.00019586 at  $40^{\circ}$ , 0.00025160 at  $60^{\circ}$ , and 0.00036390 at  $80^{\circ}$ . Near the fusing point the increase is more rapid. (*J. Phys.*, January, 1881, x, 41.)

Comstock has called attention to a variation in the length of a zinc bar at the same temperature. The United States Lake Survey possesses a meter made by Repsold, composed of a bar of steel and one of zinc so arranged as to form a metallic thermometer. It has also a base-measuring apparatus by the same maker, containing cast-iron tubes four

meters long, and having in its interior a bar of steel and one of zinc, also forming a thermometer. Irregularities in the results of comparisons of two bars in the same tube led to an examination of the question whether a zinc bar has always the same length at a given temperature. The comparisons were made with great care, and every precaution taken to avoid error. The results showed that the zinc bar of the standard meter, heated for 20 hours or more to a temperature of  $70^{\circ}$  F., and then allowed to cool to its original temperature,  $36^{\circ}$  F., has a certain length; that if it is then cooled for 20 hours to a temperature of  $-3^{\circ}$  F., and afterward is allowed to return gradually to its original temperature of  $36^{\circ}$  F., it has a certain other length; and that these lengths at the same temperature may differ by 15 microns (thousandths of a millimeter). The four-meter zinc bar heated from  $41^{\circ}$  to  $75^{\circ}$  F., and then cooled to  $43^{\circ}$  F., was increased in length about 29 microns, or 7 microns per meter for a change of  $30^{\circ}$  F. (*Am. J. Sci.*, III, July, 1881, xxii, 26.)

Miss Walton has studied, in the Massachusetts Institute of Technology, the phenomena of liquefaction and cold produced by the mutual reaction of solid substances. With reference to liquefaction, the following conclusions are drawn: (1) as a rule one of the substances should be hydrated; (2) moistening sometimes take place when salts are mixed with acids, or with bases, and when acids and bases are mixed, as well as salts; (3) as with liquids, if metathesis can result, it will take place with liquefaction; (4) if an insoluble compound is formed on mixing two salts, a mixture of two others, like the new ones formed, will not in general be attended with liquefaction; (5) if no insoluble compound is formed metathesis is partial, and it is often indifferent whether two salts be mixed or their products of interchange; (6) the rule in liquids in regard to weak and strong acids and bases seems to prevail with solids also; (7) when oxidation or reduction can take place there is possibility of liquefaction. On the production of cold the author accepts Ordway's view, that the liquefaction of salt by ice is due to the diffusion which goes on between them, analogous to that between liquids. The mixtures were made in a calorimeter, and the results showed that the minimum temperature is not independent of the initial temperature, and that, moreover, this minimum varies with the proportions taken. The lowest temperature was given by mixing equivalent weights of manganous nitrate and sodium carbonate at  $-2^{\circ}$  C., the temperature falling to  $-26^{\circ}$  C. (*Am. J. Sci.*, September, 1881, III, xxii, 206.)

Hagenbach has experimented on the rupturing effects of the freezing of water. During the severe cold at Bâle on the nights of the 10th and 11th December, 1879, and the 20th and 21st January, 1880, he filled artillery shells with water and observed the phenomena which took place. The shells were burst, and the ice, afforded free passage, showed a filamentary structure, like suddenly congealed jets of water. The water, suffused within the shell, was cooled to a low temperature without



solidifying; so that, after rupture of the shell, the congelation took place. The curious appearances of the jets are figured in the memoir. (*Bib. Univ.*, 1880, III, iii, 531; *J. Phys.*, April, 1881, x, 181.)

The paradoxical experiment of "hot ice" described by Carnelley has been repeated by many observers in various ways. Lodge has discussed the matter on general principles, conceding that the ice itself may be hot, a proposition in which he thinks there is nothing contradictory to our present knowledge of the properties of matter. Carnelley himself has published an additional paper, with figures, in which he says: "I have had thin plates of ice attached by their edge at right angles to the stem of a paper-scale thermometer for a considerable time without being detached or melting, notwithstanding the temperature was so high that the paper scale at that portion of the stem to which the ice clung was charred. In another instance I have had a thin circular piece of ice attached to the otherwise bare bulb of the thermometer, and though this piece was very thin, and no more than about 2 millimeters in diameter, it took fully one minute or more to volatilize, notwithstanding the thermometer indicated a mean temperature of  $70^{\circ}$  C., and the surrounding tube was very hot. If the ice were not capable of being heated above its melting point, a piece as small as that referred to would, I think, under these circumstances have fused or volatilized almost instantaneously." Herschel has contrived a remarkably simple apparatus for showing the phenomena. A 30-ounce flask of heavy glass was tightly closed by a rubber cork through which passed a tube three-eighths inch bore and 2 feet long, bent into the shape of an S, and the extremity drawn into a nearly capillary neck. This neck was connected by a rubber tube with a similar flask, to which was attached an exhaust pump, and which was immersed in cold water. Fifteen ounces of water were then boiled in the flask thus exhausted, and when only 3 ounces remained the small end of the tube was sealed. The U-part of the tube was put in a freezing mixture till a sleeve of ice was formed eight inches long. Then the flask was similarly treated, and the tube was heated first in a water-bath, then by the naked flame. He says: "The whole tube was heated violently, without for some time appearing to have the least effect upon the white crust within, notwithstanding the tube was too hot to be touched." De la Rivière and Van Hasselt have repeated the experiments carefully, with the aid of accurate thermometers. They find the ice itself is generally at  $-7^{\circ}$  C., though when the heating is very strong it may rise to  $0^{\circ}$ . They found that the result could easily be obtained with naphthalene. Hannay has constructed an apparatus, from ordinary laboratory materials, with which he has examined the phenomena very critically. He performed the crucial experiment of placing a bulb containing frozen water and open to the air, inside the mass of ice within the exhausted tube. The ice within the bulb did not melt even when the tube round the ice *in vacuo* was raised to the point of softening. The results of McLeod, Lothar Meyer, Boutlerow, Peters-

son, and Young are to the same purpose. (*Nature*, 1881, xxiii, 264, 288, 341, 383, 504; xxiv, 4, 28, 77, 113, 167, 239; *Ber. Berl. Chem. Ges.*, April, 1881, xiv, 718.)

Chandler Roberts and Wrightson have determined the density of melted bismuth by means of the oncosimeter, an instrument devised by the latter gentleman. It is composed of a ball of the metal whose density in the melted state is to be studied, or of a metal less fusible. It is suspended at the extremity of a spring and is completely immersed in the fused metal. The difference, either positive or negative, between its weight and the upward pressure when in the liquid is measured by the lengthening or shortening of the spring, and is registered by a lever on a rotating cylinder. The value of this difference at the moment of immersion, before the ball has had time to heat, gives data for the calculation of the specific gravity of the liquid, that of the ball having been determined. The authors find for the specific gravity of melted bismuth 10.055, that of solid bismuth being 9.82; for iron in fusion 6.84; in the pasty state 6.33; and cold 6.95. (*Phil. Mag.*, April, 1881, V. xi, 295.)

Nies and Winkelmann have investigated the volume changes of various metals in solidifying. Of eight metals examined, six, viz, tin, zinc, bismuth, antimony, iron, and copper, were proved to undergo expansion in passing from the liquid to the solid state. For three of the metals approximate values for the amount of this expansion were obtained. Tin showed an expansion of 0.7 per cent., zinc 0.2, and bismuth 3. Two metals, lead and cadmium, gave doubtful results. The authors have reason to believe that they also expand in solidifying. If this be so, the rule would appear to be a general one for the metals. (*Nature*, April, 1881, xxiii, 616.)

Fornioni has described an evaporimeter with constant level. It consists of an oblong wooden case with a brass spiral descending into it from a micrometric screw. The spiral carries at its lower end a small glass vessel, which acts as feeder. A glass siphon extends outward horizontally from the feeder and has at its outer end a small cup in which the evaporation takes place. As the water evaporates in the cup the feeder is lightened and rises by the action of the spiral, thus keeping the level constant. A fine layer of oil in the feeder prevents evaporation from its water-surface. There are guides to control the vertical movements of the feeder, which moreover are indicated by means of a weighted thread affecting an external index on a disk. The graduation of the instrument is expressed in millimeters of the height of water in the evaporating vessel. (*Nature*, August, 1881, xxiv, 387.)

Van der Mensbrugghe has calculated that if evaporation subdivides the liquid of seas into spherules of, say,  $\frac{1}{150000}$  millimeter in diameter, each kilogram of water presents a collection of spherules whose total potential energy is equivalent to 450 kilogram-meters, i. e., more than a million times that of a sphere of compact water also weighing a kilo-

gram. The potential energy of liquid surfaces plays thus an important part in the great cycle-operations of nature, of which the author gives some instances. (*Nature*, January, 1881, xxiii, 278.)

Wüllner and Grottrian have made observations which seem to prove that the specific volume of vapors is independent of the size of the space in which it is determined. They confirm Herwig's result, that vapors always undergo precipitation before reaching the so-called maximum tension. Moreover, the tension at which condensation begins is found to have a relation to the maximum tension which depends on the nature of the liquid but is nearly independent of the temperature. Experiments to find the degree to which vapors must be compressed to give the maximum tension showed that there is no maximum tension in the sense hitherto accepted; but that the tension of saturated vapors, even when in contact with an excess of liquid, is perceptibly increased by compression. (*Wied. Ann.*, 1880, II, xi, 545; *Nature*, February, 1881 xxiii, 307.)

Wright has contrived a simple and convenient form of apparatus for the distillation of mercury *in vacuo*, which is an improvement upon those of Weinhold and Weber for the same purpose. A straight piece of heavy glass tube, 5 or 6 millimeters interior diameter and rather more than 76 centimeters long, is enlarged at one end to an oval bulb 85 millimeters diameter and 120 millimeters long. To the upper end of this a tube 15 millimeters interior diameter is joined, first rising 25 millimeters, then inclined towards the bulb 130 millimeters, then sloping from the bulb for 300 millimeters, and finally joined to a straight vertical tube 1 millimeter in diameter and 90 centimeters long. At the junction is a lateral tube for connecting with the air-pump. The metal to be distilled is placed in a cistern beneath the 76-centimeter tube; the apparatus is exhausted, by means of a Sprengel pump, until the mercury from the cistern reaches the bulb. Then the tube to the pump is sealed and heat applied to the bulb very gradually. The vapor soon passes the bend at the top and condenses beyond it, running down into the 90-centimeter tube. At the bottom this tube is bent upward, a small bulb is blown on it, and it is then bent horizontally. As the mercury falls in the tube it maintains the exhaustion, the tube acting like a Sprengel pump. The distillation is rapid, from 400 to 450 grams per hour being easily obtained pure in this manner. (*Am. J. Sci.*, December, 1881, III, xxii, 479.)

### 3. Conduction and radiation.

Christiansen has employed the following simple method for some experiments on heat conduction which he has made: Three round copper plates were placed one above another and separated by small pieces of glass. Into each plate a hole was bored radially, into which a thermometer was inserted. The lowest plate rested on a brass vessel, through which cold water is conducted. On the top plate rests a brass vessel, through which warm water circulates. Through holes in the

two upper plates, having copper stoppers, the intervals between the plates may be filled with fluid. Air was first used, and the author proved that its conductivity for heat increases with the temperature. The ratio of the conductivity of air to that of liquids was studied, the liquid being placed in the lower space. Experiments were also made with dry and wet plate glass and also with marble. The author points out the applicability of his apparatus to measure resistances, the potential being measured instead of temperature. (*Nature*, October, 1881, xxiv, 593.)

Crookes has made a series of experiments on the conduction of heat in highly rarefied air. An accurate thermometer with a pretty open scale was inclosed in a  $1\frac{1}{2}$ -inch glass globe, the bulb of the thermometer being in the center and the stem being inclosed in the tube leading from the globe to the pump. The globe was brought to a uniform temperature in a vessel of water at  $25^{\circ}$  and was then suddenly plunged into a large vessel of water at  $65^{\circ}$ . The number of seconds required for the thermometer to rise from  $25^{\circ}$  to  $50^{\circ}$  was recorded. At 760 millimeters pressure, 121 seconds was required; at 1 millimeter, 150 seconds; at 620 M (millionths of an atmosphere), 162 seconds; at 117 M, 183 seconds; at 59 M, 203 seconds; at 23 M, 227 seconds; at 12 M, 252 seconds; at 5 M, 322 seconds; and at 2 M, 412 seconds. Hence there is not only a notable diminution in the rate at which heat is conveyed across the space in the bulb, but the reduction of pressure from 5 M to 2 M produces twice as much retardation in the rate as is obtained by the whole exhaustion from 760 millimeters to 1 millimeter. The author thinks, therefore, that in such vacua as exist in planetary space the loss of heat would be exceedingly slow. (*Nature*, January, 1881, 234, xxiii.)

Langley has devised an apparatus for the detection and measurement of radiant heat, which is a thousand times more sensitive than the thermopile, and which is capable of indicating a change in temperature of  $\frac{1}{100000}$  of a degree centigrade. He calls it an actinic balance or bolometer. It consists of two disks of ebonite, 30 millimeters diameter and 3 millimeters thick, each with a concentric opening in the center 8 millimeters square. On the face of each disk strips of iron a little less than 0.5 millimeter wide and about 0.004 millimeter thick cross the opening like a grating, those on one disk coming opposite the intervals in the other. These twenty-nine strips, of which fifteen are on one disk and fourteen on the other, are arranged in two sets, fifteen in one and fourteen in the other. The first set, eight on one disk and seven on the other, are placed centrally; the second set is divided, one-half being on each side of the other set. The strips in each set are all connected together in series so that an electric current would traverse them successively. The two disks are fastened together and placed in a hollow cylinder of ebonite, lined with copper, and provided with suitable diaphragms. Each of the sets of strips is made one side of a Wheatstone's

bridge, and the current from one or more Daniell cells is sent through them. When the two currents are equal the needle of the galvanometer is unaffected. But when radiant energy falls on one of the systems of strips and not on the other, the current passing through the first is diminished by the increased resistance of the metal due to the rise in its temperature. As the second remains unaltered, the needle is deflected. Moreover, owing to the thinness of the strips, they take up and part with their heat far more promptly than the thermopile, thus giving a much greater rapidity of working. Results are given showing the extreme sensitiveness and reliability of the instrument. For the first time it has been possible to make actual measures of the distribution of heat in the diffraction spectrum. This was done by Langley with the bolometer, using a Rutherford plate of 681 lines to the millimeter, ruled on speculum metal. The spectrum was 20 centimeters long and 8 millimeters wide; so that the balance received nearly homogenous rays. The extremely minute amount of heat received was found sufficient to give a galvanometer deflection of some hundred divisions; and this where thermopiles have failed to detect anything. The deflections observed for different wave-lengths were: for  $\gamma=.00035$ ,  $\alpha=12$ ;  $\gamma=.0004$ ,  $\alpha=55$ ;  $\gamma=.0005$ ,  $\alpha=207$ ;  $\gamma=.0006$ ,  $\alpha=246$ ;  $\gamma=.0007$ ,  $\alpha=198$ ;  $\gamma=.0008$ ,  $\alpha=129$ ;  $\gamma=.0009$ ,  $\alpha=80$ ;  $\gamma=.0010$ ,  $\alpha=58$ ;  $\gamma=.0011$ ,  $\alpha=41$ . The maximum deflection for heat, then 246, corresponds to a wave-length of .0006, that of D being .00059, giving the conclusion that the heat maximum in a normal spectrum is not in the ultra-red, as has been supposed, but is in orange, near D, the heat and light curves agreeing very closely. The value of the instrument is obvious. (*Am. J. Sci.*, March, 1881, *III*, xxi, 187; *Proc. Am. Acad.*, January, 1881, xvi, 342; *Nature*, November, 1881, xxv, 14.)

Puluj has devised an ingenious experiment to prove that radiant matter consists of particles separated from the electrode by the electrical action. The cathode of a vacuum tube was covered with chalk. It exhibits phosphorescence of an orange-yellow color, while in a short time the wall of the tube becomes covered by a very delicate layer of chalk without losing its clearness and transparency. The deposit phosphoresces like chalk, and has led to the suggestion which he makes, that the phosphorescence of a yellow color observed on metallic cathodes is caused by the phosphorescence of the oxides covering the metal. (*Nature*, March, 1881, xxiii, 442.)

The photophone and its results, discovered by Graham Bell and Tainter (see report for 1880), have awakened a very general interest. Rayleigh has given a discussion of the question whether the unelectrical sounds produced by the simple impact of intermittent radiation upon thin plates of various substances can be accounted for by the heat produced. He finds that if a plate of iron 6 centimeters in diameter be exposed to an intermittent beam of sunlight at 250 vibrations per sec-

ond, the displacement at its center would be five-millionths of a centimeter. Since he found sound audible whose amplitude was less than half this value, he concludes that at present there is no reason for discarding the obvious explanation that the sounds in question are due to the bending of the plates under unequal heating. (*Nature*, January, 1881, xxiii, 274.)

Jamieson has devised a simple form of selenium cell, made of a piece of plate glass or a glass tube, an inch in diameter and 3 inches long, upon which are wound two parallel strands of No. 25 wire. Vitreous selenium is melted into the spaces between the wires, and then annealed in the usual way. One of these cells had a resistance of 5,740 ohms in the dark and 3,450 in the light. An annular cell, placed outside the tube of a swinging flame, transmitted its note perfectly to the telephone, and, by placing a flat cell before the gas-flame of a Koenig manometric capsule, and talking into the tube on the outer sound of the membrane, conversation could be carried on. (*Nature*, February, 1881, xxiii, 354.)

S. P. Thompson has suggested to the London Physical Society the use of a conical instead of a parabolic reflector for the photophone. From Adams's law, that the change in the resistance of selenium is directly as the square root of the illuminating power, he finds that the change in resistance of a cell will vary proportionally to its linear dimensions; hence, selenium cells should be as large as possible, and the light should be distributed over them uniformly. His cell was constructed of a slate cylinder with a double screw-thread wound with wire and filled with selenium. (*Phil. Mag.*, April 1881, V, xi, 286; *Nature*, February, 1881, xxiii, 331.)

Tomlinson has found that a stick of annealed selenium gave twice the deflection when coated with shellac varnish that it did when in its natural state. (*Nature*, March, 1881, xxiii, 457.)

Tyndall has presented to the Royal Society a paper on the action of an intermittent beam of radiant heat upon gaseous matter, giving the results of the use of the photophonic method to test the absorptive action of aqueous vapor for heat—a subject long in controversy. The experiments were made by converging the intermittent beam to a focus within a flask containing the vapor to be examined. Sulphuric ether, formic ether, and acetic ether gave loud musical tones, while those from chloroform and carbon disulphide were barely perceptible, corroborating his previous experiments. The power of amylene, ethyl and methyl iodides, and benzene vapors to produce musical tones appeared to be accurately expressed by their ability to absorb radiant heat. Gases gave the same result. Turning now to water, a small quantity was heated in a flask to a point near boiling; in the intermittent beam it gave a powerful musical sound, even when no haze was present. Cooling to 10° C. did not prevent the sound from being loud, and even ordinary air cooled in a freezing mixture for a quarter of an hour gave

distinct sounds. In carefully dried air only the feeblest sound was heard, but a puff of breath instantly restored its power to absorb. Many beautiful and striking experiments are described in the paper. (*Proc. Roy. Soc.*, January 13, 1881, xxxi, 307; *Nature*, February, 1881, xxiii, 374.)

Mercadier has studied photophone phenomena with great ability, and has given the name radiophony to the general subject. In the first part of his memoir he describes his apparatus, and, from the results obtained with it, concludes: (1) that radiophony does not appear to be an effect produced by the mass of the receiving plate vibrating transversely as a whole like an ordinary vibrating plate; (2) that the nature of the molecules of the receiver and their mode of aggregation does not appear to play a predominant part in the production of sounds; (3) that the radiophonic phenomena seem to result principally from an action exerted at the surface of the receiver; (4) that radiophonic sounds result from the direct action of the radiations upon the receiver; and (5) the radiophonic effects are produced principally by red and ultra-red rays; that is to say, by rays which consist of long waves. In the second part of his paper Mercadier gives the experimental evidence that the substance in which the vibration is produced is the layer of air in contact with the walls of the receivers. The receiver used is a glass tube, open or not, at one end, and the other connected by a tube of rubber with a small acoustic cornet. Within the tube is a semi-cylinder of some flexible material, paper, mica, copper, zinc, platinum, aluminum, etc., smoked on both sides. Since the sound is the same, whatever the material, the conclusion is obvious that it is the air condensed by the lampblack which vibrates. He says: The layer of air condensed on the walls of the receiver, especially when they are smoked or covered with a substance highly absorbent for heat, is alternately heated and cooled by the intermittent radiations. From this, periodical and regular dilatations and condensations take place and communicate a vibratory motion to the neighboring gaseous layers, which, moreover, may themselves also vibrate directly under the same influence. If a long tube of glass be taken, furnished with a piston at the end of a rod, a piece of smoked mica be placed in it, and the other end be connected with a cornet, then whenever an intermittent beam falls on the mica a sound is heard, which may be made a maximum by moving the piston. Further motion shows a second and a third maximum, thus discovering the nodes in the vibrating air column. This apparatus the author calls a thermophone. The tube receiver, closed at the lower end, is excellent for experiments upon gases and vapors, in which, however, the author was anticipated by Tyndall. In the third paper the means which Mercadier used for the production of singing and speech are described. This was presented to the French Academy the same day that Bell read his memoir on the same subject to the National Academy. (*J. Phys.*, February, April, June, 1881, x, 53, 147, 234; *Nature*, February, 1881, xxiii, 360.)

Preece has made some experiments on the conversion of sonorous vibrations into radiant energy. The conclusion to which he came was that the disk itself did not vibrate at all, but that the effect is essentially due to the expansion and contraction of the air contained in the air space behind the disk, the sonorous effects being materially assisted by coating the sides of the containing vessel with a highly absorbent substance, such as the carbon deposited by burning camphor. (*Proc. Roy. Soc.*, March, 1881, xxxi, 506; *Nature*, March, 1881, xxiii, 496.)

In a second memoir, which was presented to the National Academy of Sciences April 21, 1881, Graham Bell has given an account of the further researches made by Tainter and himself on the production of sound by radiant energy. While in Paris, in the fall of 1880, a new form of the experiment occurred to Bell which would enable him to test the question whether sonorousness under the influence of intermittent light is not a property common to all matter. Preliminary experiments were made, and were so promising that they were communicated to the French Academy on the 11th of October. On the 2d of November he wrote to Tainter, in Washington, as follows: "Place the substance to be experimented with in a glass test-tube; connect a rubber tube with the mouth of the test-tube, placing the other end of the pipe to the ear; then focus the intermittent beam on the substance in the tube." In January, on returning to Washington, Bell found that Tainter had made the experiments on a large number of substances, and had found that cotton-wool, worsted, silk, and fibrous materials generally produced much louder sounds than hard, rigid bodies like crystals or than diaphragms. Black worsted giving so good a result, he desired to try black cotton-wool; but having none at hand he made some by mixing some lamp-black with the cotton. The effect was so marked that he tried lamp-black alone, with entire success. It was the loudest material yet used, and was immediately utilized in the construction of an articulating photophone in place of the selenium receiver. The transmitter as well as the receiver had a diaphragm 5 centimeters in diameter, and the distance between the two was 40 meters. No heliostat or condensing mirror was used; and words spoken into the transmitter in a low tone of voice were readily audible in the lampblack receiver. With reference to Preece's experiments, Bell maintains that the disks themselves vibrate, as a loud sound is heard from a Blake transmitter when the intermittent beam is focused on its disk. An ingenious experiment devised by Tainter seemed to confirm this beyond dispute. Experiments with liquids and with gases are recorded; and two receivers where lamp-black is used in place of selenium are described. Valuable methods and results are given on the measurement of the sonorous effects produced by different substances, and also upon the nature of the rays that produce them. Bell adopts Mercadier's name, radiophone, and has studied the spectrum to determine the active rays. The instrument employed he calls a spectrophone, and the results obtained with it are given in a



series of spectra by which the substances used can be identified, thus forming a true acoustic spectrum analysis. (*Am. J. Sci.*, June, 1881, III, xxi, 463; *O. R.*, xcii, 1206; *Phil. Mag.*, June, 1881, V, xi, 510; *Nature*, May, 1881, xxiv, 42.)

In a third paper, Graham Bell has described a modification of Wheatstone's microphone, and pointed out its applicability to radiophonic researches. Preece's failure to detect the vibration of the diaphragm was due to the fact that he used a Hughes form of the instrument, in which the points of support are too far from the center where the maximum vibration exists. In 1827, Wheatstone invented a microphone, consisting of a metallic diaphragm, to the middle of which a stiff wire was rigidly attached. By inclosing this in a case somewhat like that of a telephone, the wire projecting through the end of the handle and a tube for hearing being fitted to the opposite end, the surface of the radiophonic diaphragm may be explored. When it rested on the center of this diaphragm a clear musical note was heard, showing that the diaphragm itself vibrated. (*Am. J. Sci.*, August, 1881, III, xxii, 87.)

Ayrton and Perry, observing the facility with which the invisible rays which affected the selenium in Bell's photophone passed through ebonite, concluded that these rays would be refracted by an ebonite prism. This conjecture they were able to confirm experimentally. Moreover, by suitably arranging the apparatus, the prism having a refracting angle of  $27^{\circ}.5$ , they succeeded in measuring the index of refraction for these rays, which they found to be 1.7. This result accords with that obtained by Jellett from the polarizing angle, 1.611, and with that obtained when the light is very intense, so that the red rays can be faintly seen, 1.66. (*Phil. Mag.*, Sept., 1881, V, xii, 196; *Nature*, 1881, xxiii, 519; *J. Phys.*, November, 1881, x, 507.)

#### 4. *Specific heat.*

Mallet has described a simple form of calorimeter for determining the specific heat of solids and liquids with small quantities of material. It consists of a cylinder of vulcanite 105 millimeters long and 64 millimeters inside diameter, 1.5 millimeters thick, closed at the ends by round plates of the same material screwed on. Within this is an inner cylinder, also of vulcanite, 22 millimeters in interior diameter, passing closely through a hole in one of the end caps and screwing into the other. The space between the two is filled with vulcanite shavings. Both ends of the inner tube are closed by corks, through one of which passes the stem of a mercurial thermometer, graduated to tenths. A diaphragm with a hole 7 millimeters in diameter in its center is fixed in the inner tube 47 millimeters from one end, and carries three platinum wires so bent as to hold a small platinum cylinder firmly. This cylinder, intended to contain the substance for experiment, is 28.5 millimeters long by 12.5 millimeters diameter, weighing with its cover 6 grams. The outer cylinder is mounted on trunnions and supported on

a wooden frame. A weighed quantity of pure mercury—generally 220 grams—is placed in the inner cylinder. By moving the whole around on its trunnions, this mercury may be poured from one part of the inner cylinder to the other, and the temperature thus equalized. The substance whose specific heat is to be determined is placed in the platinum cylinder, which is then heated in a special apparatus to the temperature of boiling water, transferred rapidly to the calorimeter, and this moved on its trunnions until the temperature ceases to rise. The highest point being noted, the specific heat is easily calculated. The various precautions necessary, and the methods for determining the constants of the instrument, are given in the paper. (*Am. Chem. J.*, February, 1881, ii, 361.)

Willner has examined critically the formulas in use for calculating specific heats, especially that portion of these formulas which involve the corrections. He finds that the inexactness of the ordinary formula arises from the fact that it does not take account of the condition that during cooling the calorimeter value is increased by the product of the weight and specific heat of the substance, and that the change in the magnitude of the radiating surface is neglected. He has calculated the specific heat of water by the new formula now derived, and finds that the equation  $k=1+0.000425t$  represents this constant at  $t^{\circ}$ . (*Wied. Ann.*, 1880, II, x, 284.)

Pfaundler has published a criticism on this paper, in which he points out certain errors of experiment and assumption. The process of Regnault, as modified by Berthelot, is the most exact known, and is free from all objection. In this the variation of temperature during the cooling of the body is measured at regular intervals; then the calorimeter containing the substance is brought back to the initial temperature and made to pass through all the temperatures observed in the first experiment, and the loss of heat is measured. (*Wied. Ann.*, 1880, II, xi, 237; *J. Phys.*, January, 1881, x, 43, 47. See also Berthelot, *J. Phys.*, February, 1881, x, 79.)

Latschinoff has modified the lecture experiment proposed by Tyndall for showing the inequality of the specific heats of solids. Since the densities of the materials are not the same, the surfaces of various spheres of the same weight are not equal, and an error is introduced. This the author obviates by employing hollow spheres of the same weight and the same diameter. In place of a plate of wax, the author places the heated spheres on the surface of a transparent jelly of gelatin, and notes their unequal penetration. (*J. Phys.-Chim. Soc. Russe*, xii, 131; *J. Phys.*, September, 1881, x, 418.)

#### LIGHT.

##### 1. Production and velocity.

Michelson has made a research to test the truth of Fresnel's theory, that the ether which is inclosed in optical media partakes of the motion

of these media to an extent depending upon their indices of refraction. The principle of the experimental method is simple: If a ray of light coming from a direction parallel with the earth's motion in space be made to interfere with a second ray coming from a direction  $90^\circ$  from this, the former ray will have traveled 0.04 of a wave-length farther or less far than the latter, according as the direction of its motion coincides with or is opposed to the motion of the earth. Now, upon rotating the two rays  $90^\circ$  in their own plane, the second one will now have a longer path by 0.04 wave-length, making a total change in the position of the interference bands of 0.08 wave-length, a quality easily measurable. The apparatus used is described and illustrated in the memoir. The results go to show that there is no displacement of the interference bands, thus contradicting the hypothesis of a stationary ether, and disproving the explanation of aberration hitherto generally accepted. (*Am. Jour. Sci.*, August, 1881, III, xxii, 120.)

J. J. Thomson has given an ingenious explanation of the green phosphorescence observed in Crooke's tubes. It appears on the inner surfaces of the exhausted glass tubes whenever they are exposed to the so-called molecular bombardment of particles projected from the negative electrode. Thomson points out, first, that as predicted by Maxwell, and verified by Rowland, a moving electrified particle acts as a current of electricity and possesses an (electro-magnetic) vector-potential. Now, where such an electrified particle strikes a glass surface and rebounds, its change of velocity is accompanied by a change of vector-potential, and the glass against which it impinges and rebounds will be subjected to rapid changes in electromotive force. But by Maxwell's theory of light this is precisely what happens when a ray of light falls on it; and, therefore, it phosphoresces as it would under the impact of an actual ray of light. (*Nature* May 19, 1881, xxiv, 66.)

Trève has shown the curious fact that apparently, when light from a natural or artificial source is admitted through a slit, more light passes when the slit is horizontal than when it is vertical. Photographs were taken behind slits in various positions to prove that the phenomenon is not an illusion of the eye. (*Nature*, April, 1881, xxiii, 616.)

Young and Forbes have employed Fizeau's toothed-wheel method to determine the velocity of light. Instead of a single reflector at a distance, two were used, one a quarter of a mile behind the other. Two rays were also used, which were observed when equally bright, a point reached by adjusting the speeds of the toothed wheels. The general result reached was that the velocity of the light of an electric lamp is 187,273 miles per second *in vacuo*. Noticing one day that one of the stars looked reddish, the other bluish, the former increasing in intensity with the speed of the wheel, the latter decreasing, the authors concluded that the blue rays must move faster than the red ones, and instituted direct experiments to test the question. As a mean of 37 determina-

tions they conclude that blue travels faster than red by 1.8 per cent. of the whole velocity. Since their result for the mean velocity is greater than that of Cornu or Michelson, Forbes draws the conclusion that it is because the electric light is blue, and blue travels faster than red. (*Proc. Roy. Soc.*, May, 1881; *Nature*, June, July, 1881, xxiv, 135, 303.)

Rayleigh has discussed the above results, raising the question whether the velocity determined by the toothed wheel is really the group-velocity or the wave-velocity as the above authors have supposed it to be, since they give the difference between blue and red. He concludes that the group-velocity is what the method determines. The accordance between the physical and astronomical methods seems to show that there can be no such difference in the velocities of the extreme rays as 1.8 per cent. (*Nature*, August, 1881, xxiv, 382.)

Michelson has published a note in which he gives his opinion that if the velocity of the red and blue rays differed by as much as one-tenth of one per cent. the image of the slit in his experiments would not have been white, but would have been spread out into a spectrum. He calculates that, as the total displacement in his experiments was 133 millimeters, a difference of velocity of 1.8 per cent. between the blue and red rays would have given a spectrum 2.4 millimeters in length. No such spectrum was observed. (*Nature*, September, 1881, xxiv, 460.)

Cornu has described several forms of photometric and spectrometric apparatus, which he has used in his researches. They all are founded upon a property of lenses discovered and utilized by Bouguer; *i. e.*, that the focal image, as to form, is independent of the size and shape of the aperture of the lens, and as to intensity is proportional to the surface of this aperture. One form of the apparatus he calls a micro-photometer and another form a spectro-photometer. (*J. Phys.*, May, 1881, x, 189.)

## 2. Reflection and refraction.

Jacob has suggested a modified form of scale for use with reflecting instruments generally. The graduated paper scale is trimmed off along the lower edge of the divisions, and placed on a plate of glass, finely ground, below the paper. The reflected image is received on the back of the glass, and the coincidence of the center wire with the scale divisions may be observed more accurately than by the common method. The lamp and slit are placed on one side, and the beam reflected to the galvanometer mirror by a right-angled prism. (*Nature*, April, 1881, xxiii, 527.)

Bertin has published an extended memoir upon magic mirrors. After an introduction describing these mirrors, he gives a history of their importation into Europe and of the experiments made with them; then follows the theories proposed to account for their action, the experiments of Govi confirming Person's theory, the artificial production of these mirrors by himself and Duboscq, and some exceptional effects which have been observed. (*Ann. Chim. Phys.*, April, 1881, V, xxii, 472.)

Laurent Las succeeded in producing artificially magic mirrors of silvered glass. Two kinds have been made; one made magic by compressing air behind it or by curving it in a frame, the characters being engraved on it; and another, of any form whatever, heated in a particular way, by means of a metallic stamp having the characters upon it. If the layer of silver is thin, the characters are bright if the silver is on the side opposite to the screen, but are dark if the silvered side is toward the screen. (*J. Phys.*, November, 1881, x, 474.)

Klein has observed a complete change in the optical image of boracite by heating it. The boundary lines of the optical fields prove variable with temperature, and often wholly disappear, perhaps reappearing in quite different places. He concludes that this mineral does not owe its origin to a twin-like formation of parts of lower symmetry, but is regular, and produces simple individuals; and the optical properties, apparently in sharp contradiction to this, are really due to tensions produced in growth. These divide the crystal into parts of different tension of which the stronger sometimes suppress the weaker for certain temperatures and positions of the crystal. Analcime shows similar properties. (*Nature*, June, 1881, xxiv, 112.)

Cassani has devised a neat optical illusion produced with mirrors. An observer stands opposite a concave mirror supported at a slight slant, at a distance greater than the radius of curvature, and receiving no other light than that reflected from his face, which is illuminated by a dark lantern. A small plane mirror is placed in a position nearer the concave mirror than the observer and sloping in the opposite direction, concealed from his view. On looking obliquely upward the observer seems to see a plane mirror larger than the other, with his direct image in it. The illusion is more complete if the mirror has an ornamented frame. (*Nature*, February, 1881, xxiii, 372.)

Montigny has proposed a method for measuring the index of refraction of liquids, founded upon the apparent displacement which the image of a body immersed in a transparent liquid undergoes when the light-rays reaching the eye issue oblique to the horizontal surface of the liquid. (*Bull. Acad. Blelege*, II, xviii, —; *J. Phys.*, January, 1881, x, 50.)

Hurion has suggested an apparatus for simplifying the method of determining indices of refraction by means of Talbot's fringes, proposed by Mascart. Its object is to vary the level of liquid in one of two compartments, so as to displace the fringes by a known value. The displacement and change of thickness being known, the index is easily calculated. (*J. Phys.*, April, 1881, x, 154.)

Damien has measured the index of refraction of water when in a state of surfusion, by the ordinary method, with the prism. The three hydrogen lines were measured. From the figures obtained he concludes that

the index of refraction of water continues to increase below zero, though the density diminishes. (*J. Phys.*, May, 1881, x, 198.)

Long has determined the indices of refraction of eighteen compound ethers of the  $C_nH_{2n}O_2$  series, at various temperatures, from  $18^\circ$  to  $25^\circ$  C. As a mean, the increase of the index for  $1^\circ$  C. is .00045. From the results, he calculates the specific refractive energy  $\frac{n-1}{d}$  and the mole-

cular refractive energy  $M \left( \frac{n-1}{d} \right)$ . Comparing together the optical constants of the butyrates and isobutyrate, it is found that they are lower in every case in the iso-compounds than the normals. The change in molecular refraction for  $CH_2$  is found to be, as a mean, 7.69. From this the atomic refraction of oxygen is obtained, 5.77. (*Am. J. Sci.*, April, 1881, III, xxi, 279.)

Dufet has studied the variation which takes place in the indices of refraction of gypsum with temperature, and finds that the three principal indices diminish as the temperature increases by quantities relatively considerable, but very unequal, compared with each other. (*J. Phys.*, December, 1881, x, 513.)

Gladstone has communicated to the Royal Society a paper on the refraction equivalents of carbon, hydrogen, oxygen, and nitrogen in organic compounds. The refraction equivalent of carbon, when each of its four bonds is satisfied by some other element, does not exceed 5; when one bond is satisfied by carbon and the others by other elements, the value is 5; when three bonds are satisfied by carbon, as in benzene, the value is 0.0 or 6.1; and, finally, when all four of its bonds are satisfied by carbon atoms having the value 6, the carbon atom has its highest equivalent, 8.8. Hydrogen has only one refraction equivalent, 1.3. Oxygen has two—3.4 where it is doubly united to a single atom, but 2.8 where it joins two other atoms. Nitrogen also has two values, 4.1 in the cyanides, and 5.1 in organic bases and amides. (*Nature*, February, 1881, xxiii, 379.)

Crova has made a study of the aberrations produced by prisms, and of their influence upon spectroscopic observations. In the first portion he discusses the conditions necessary to obtain a pure spectrum with a minimum of curvature in its lines. He recommends: 1st, a short slit and short prism; and, 2d, a collimator of small diameter and of long focus to increase the sharpness of the lines, and a telescope also of long focus to increase the magnification. The second part considers the cylindrical aberration of prisms, and the third the influence of the elliptical polarization introduced by reflecting prisms, and its correction. (*Ann. Chim. Phys.*, April, 1881, V, xxii, 513.)

Anderson has contrived an apparatus called a prismatic optometer, the object of which is to find experimentally the amount of prismatic power and the distance of the center of the lenses which are required in any individual case to so bend the pencils of rays coming to the eyes

that they appear to diverge from a point corresponding to the new focal distance of the eyes provided with the spectacles. (*Nature*, October, 1881, xxiv, 618.)

Gariel has described a lens of variable focus contrived by Dr. Cusco, for illustrating accommodation in the eye by a variation of the curvature of the crystalline lens. A metallic drum has its ends closed by plates of glass uniform in thickness. A rubber tube communicates with the interior at one end and has an elastic bag at the other. The whole being filled with water, positive or negative pressure produces at will a convex or a concave lens. (*J. Phys.*, February, 1881, x, 76.)

Crova has suggested the use of a pair of lenses one plano-concave and the other plano-convex, of the same focus, placed in the path of the rays and separable from each other by a rack-work, for the purpose of varying the magnitude of an image on the screen, when the distance between this and the lantern is fixed. (*J. Phys.*, April, 1881, x, 158.)

Pickering, in a paper read before the American Academy, has suggested the mounting of a large telescope horizontally, at right angles to the meridian, with a plane reflector inclined  $45^\circ$  to its axis, in front of it. He discusses the possibility of this arrangement, and points out the large number of advantages it would have in sweeping for new objects, in obtaining measures of position, in spectroscopy, and in photometry. (*Proc. Am. Acad.*, April, 1881, p. 364.)

### 3. Dispersion and color.

Thollon has investigated mathematically the passage of light through a prism, and deduces from his equations the proposition that for every prism there is an angle of minimum resolving power. Further examination shows that for a certain incidence there will be a minimum of resolution, *i. e.*, an incidence at which the lines are least well defined, and that at another incidence there will be a minimum of dispersion; these two incidences being symmetrically related to the angle of incidence corresponding to minimum deviation. A means of verifying these conclusions experimentally is given. (*Nature*, February, 1881, xxiii, 397.)

Lippich has examined the question whether it is more advantageous to increase the dispersion or to increase the magnifying power of the telescopes of a spectroscope. He concludes that it is better to increase the dispersion only when the number of prisms does not exceed four or five. His spectroscope of two flint prisms, the light passing twice through them, with a telescope magnifying from 50 to 70 times, excels another instrument having 28 flint prisms, with a telescope magnifying 10 times. (*Am. J. Sci.*, November, 1881, III, xxii, 397.)

Mendenhall has determined the coefficient of expansion of one of Rutherford's speculum metal gratings by means of spectrum measurements. The grating was ruled with 8648 lines to the inch, and the wavelength of the line measured was 5913, an iron line. The range of tem-

perature varied from  $5^{\circ}$  to  $16^{\circ}$  C., and the result of twenty measurements gave for the difference in the angle of deviation  $5.66'' \pm 0.13$ . From this the value 0.0000202 was obtained as the coefficient of expansion of the grating. (*Am. J. Sci.*, March, 1881, III, xxi, 230.)

Crookes has communicated a paper to the Royal Society on discontinuous phosphorescent spectra in high vacua, in which he gives the results of spectroscopic examination of the light from substances which have been made to emit light in the highly exhausted space within his tubes. Precipitated pure alumina phosphoresces of a rich crimson, which gives the same spectrum as that given by ruby, containing a brilliant and sharp red line of wave-length 689.5 millionths of a millimeter. The same effect is produced by sunlight. Ignited aluminum acetate gave a green, corundum a pink, sapphire alternate red and green bands, spinel red, spodumene golden yellow, glucina blue, zirconia pale bluish-green, erbia, yellowish, magnesia pink, barium hydrate orange-yellow, strontium hydrate deep-blue, lime orange-yellow, calcite straw-yellow, diamond pale yellowish-green. Certain anomalous results obtained in this way lead the author to believe that he has here to deal with several new elements. (*Nature*, May, 1881, xxiv, 89.)

Liveing and Dewar have continued their researches upon the reversal of the lines of metallic vapors, and have now given their results upon iron, titanium, chromium, and aluminum. Of iron lines 136 were reversed, 29 titanium lines, 16 chromium lines, and 2 of aluminum. Most if, not all of the strong lines of the three metals first named may be reversed by proper management of the atmosphere and supply of metal in the crucible. Fragments of magnesium dropped into the crucible aid the reversal. In this way the reversal of the strong iron lines about the solar lines L and M, four strong lines below N, the line O, all the strong lines from S<sub>2</sub> to U, inclusive, and two strong groups still more refrangible, was accomplished. (*Nature*, June, 1881, xxiv, 206.)

Huggins has photographed the spectrum of the hydrogen flame burning in air. Though so feeble, yet its spectrum shows a group of lines in the ultra-violet, limited on the more refrangible side by a pair of strong lines of wave-length 3062 and 3068, and on the less refrangible two less strong lines of wave-length 3080 and 3090. Beyond this the spectrum continues by nearly equidistant pairs of lines, among which are two of wave-length 3167 and 3171, up to wave-length 3290. This entire group the author regards as due to the vapor of water. It is equally observed when the flame is surrounded with oxygen or air. (*Ann. Chim. Phys.*, July, 1881, V, xxiii, 372; *Proc. Roy. Soc.*, 1880, xxx, 576; *J. Phys.*, February, 1881, x, 84.)

Liveing and Dewar have confirmed the above supposition of Huggins. The spectrum is not only obtained when hydrogen and hydrocarbons are burned in oxygen, but also when non-hydrogenous gases are burned, if they are moist. On drying the gases carefully this spectrum disappears. (*Proc. Roy. Soc.*, xxx, 580; *J. Phys.*, February, 1881, x, 85.)



The same authors have published their investigations on the spectrum of magnesium and magnesium-hydrogen previously observed by them. (*Nature*, June, 1881, xxiv, 118.)

Fievez has investigated the magnesium lines in the spectrum of the sun, with a view to ascertain to what their variation is due. The conclusion is that the unequal reversal of the magnesium lines is caused by a difference in the intensity of the lines themselves, and not by any particular condition of the metal. (*Ann. Chim. Phys.*, July, 1881, V, xxiii, 366.)

Huntington has examined the spectrum of arsenic, using to produce it a Plücker tube, having one of its electrodes hollow and containing the arsenic. The wave-lengths were determined from Augström's scale by comparing the lines with those of the sun, hydrogen, lithium, sodium, thallium, and strontium spectra. Twenty-three lines were thus compared, the bright and characteristic ones having wave-lengths of 6023, 6013, 5813, 5653, 5563, 5498, 5340 (the thallium line), 5103, 4623, and 4593. (*Am. J. Sci.*, September, 1881, V, xxii, 214.)

Hartley has published a paper on the relation between the molecular structure of carbon compounds and their absorption spectra. The evidence obtained is in favor of the view that the selective absorption exhibited by aromatic compounds depends on the vibrations of the carbon atoms within the molecule, but that those atomic vibrations are dependent upon the nature of the molecular vibrations themselves, and are probably to be regarded as harmonics of these fundamental vibrations. (*J. Chem. Soc.*, April, 1881, xxxix, 153.)

J. W. Draper has obtained what he calls a phosphorograph of the solar spectrum, and has compared it with a photograph of the same spectrum, as illustrating the antagonistic action of rays of higher as compared with those of lower refrangibility. A photograph taken on silver iodide, in presence of a weak extraneous light, shows three regions: (1) a blackened one extending from the boundary of the blue and green to a little beyond the violet; (2) a region in the other direction to the inferior theoretical limit of the spectrum where the action of the daylight has been altogether arrested; and (3) a similar protected region beyond the violet. In a phosphorograph, taken on luminous paint, there is annexed to the shining region a region of blackness, broken below the red by a luminous rectangle arising from the coalescence of the bands  $\alpha$ ,  $\beta$ ,  $\gamma$ , discovered by the author in 1842. If, now, a gelatin sensitive plate be laid on the shining blue phosphorescent surface, it is powerfully affected, and the constituent lines of the infra-red bright rectangle are instantly recognized in the gelatin plate. The paper deals also with the extinction of phosphorescence by red light and with the infra-red bands in the sun-spectrum. (*Am. J. Sci.*, March 1881, V, xxi, 171.)

Cornu has studied the effect of atmospheric absorption upon the ultra-

violet spectrum by means of observations made at different altitudes. He concludes that if the absorption of the ultra-violet rays was due exclusively to the action of the vapor of water distributed with the altitude according to the law which experiment indicates, the increase of visibility of the ultra-violet solar spectrum would be a unit (millionth of a millimeter) on the scale of wave-lengths for every increase of 286.9 meters. Direct observation having given three times this value, that is, a unit for 860.7 meters of ascent, the theory must be rejected that vapor of water is the exclusive cause of the absorption of the ultra-violet rays. (*J. Phys.*, January, 1881, x, 5.)

Rayleigh has communicated to the British Association some experiments which he has made on color, principally physiological. After the construction of a new instrument for the examination of compound colors, he discovered an interesting peculiarity of color-vision entirely distinct from color-blindness. The red and green mixture, which to his eyes and to those of most people matches perfectly the homogeneous yellow of the line D, appeared to his three brothers-in-law hopelessly too red, almost as red as sealing-wax. The proportion of red had to be greatly diminished to suit their eyes, until to normal sight the color was a fair green with scarcely any approach to yellow. (*Nature*, November, 1881, xxv, 64.)

Dubois has suggested an experiment complementary to that of throwing a green image and a red one on a screen, superposed for the purpose of making white. He takes a piece of red glass and a similar piece of green, pure and well-selected colors. These are placed together in a frame so that one overlaps the other by one-half its length. There are then four quadrants: one white, where there is nothing, one red one green, and the fourth black, where the overlapping occurs. (*J. Phys.*, October, 1881, x, 448.)

Lecher, using a thermo-electric apparatus in connection with a pyrheliometer, has arrived at the conclusion that the amount of carbonic acid which has been proved to exist in the air is sufficient to cause the absorption which has generally been attributed to aqueous vapor alone. He believes his method is preferable to the ordinary chemical ones for determining the amount of this gas in the air. (*Wied. Ann.*, 1881; II, xii, 466; *Am. J. Sci.*, May, 1881, III, xxi, 401.)

#### 4. Interference and polarization.

Lommel has described some simple experiments in interference, which avoid the objections made to the mirrors of Fresnel. The surface of a plane black mirror is covered with India ink, with the exception of two bands 6 millimeters wide, and 15 millimeters apart. If a solar beam from a slit falls on the mirror at an incidence of  $85^{\circ}$  to  $88^{\circ}$ , the image received on the screen is channeled with interference bands. The same result may be obtained, of course, with two rectangular mirrors a centi-

meter wide, if they are placed exactly in the same plane; but the adjustment is difficult. If, however, there is placed behind the narrow black mirror a second silvered mirror perpendicular to the first one, then the phenomena appear, the image of the first in the silver mirror answering for a second black mirror. By covering the surface of a black mirror with lines of India ink, the spaces being equal in width to the lines, beautiful grating spectra are obtained by a suitable incidence. (*Carl. Rep.*, xvi, 454; *J. Phys.*, March, 1881, x, 129.)

Fuchs has described a new interference photometer, in which no polarization of the rays at right angles is required. It consists simply of two similar isocles glass prisms joined by their basal surfaces, which inclose an air-layer variable in thickness by pressure. A diaphragm reaches out in prolongation of the surface of junction. The observer looks obliquely toward this surface, and sees one illuminated surface directly through the double prism, the other by reflection at the air layer. One source of light is fixed and the other is displaced till the interference bands disappear. (*Wied. Ann.*, II, xi, 465; *J. Phys.*, March, 1881, x, 127; *Nature*, January, 1881, xxiii, 278.)

C. S. Peirce has communicated a note on the width of the rulings on the closest-ruled diffraction-plates made on Mr. Rutherford's engine. He finds that these plates have a mean width of ruling varying in different specimens from 68078 to 68082 lines to the decimeter, at 70° F. A line in the solar spectrum has been selected for the measurement of wave-length whose minimum deviation with one of the above plates in the spectrum of the second order is 45° 01' 56". The author suggests this line as a standard of reference, since it is possible to deduce from the minimum deviation of this line produced by a given plate the mean width of the rulings on it; and consequently the wave-length of any other line whose deviation has been measured with it. Peirce finds the wave-length of this line to be 5624825; Ångström gives it 562336. (*Nature*, July, 1881, xxiv, 262.)

Cornu has constructed a polarizing prism made of a single film of Iceland spar, fixed with Canada balsam between two flint-glass prisms. The polarization is far from perfect, however, and the field is very narrow, so that the instrument, though of interest from a theoretical point of view, is of little or no practical value. (*Nature*, September, 1881, xxiv, 504.)

Glan has devised a new polarizing prism, in which the total reflection takes place on air, as in the Foucault prism; but the face of the prism is perpendicular to the incident beam and the axis of the spar is parallel to the diagonal section between the two halves of the prism. To transmit a luminous beam of section unity the length required in the new prism is 1.141, that of the Foucault being 1.228, and that of the Nicol 3.281. The maximum angle of the polarized bundle is 7° 56'; hence the rays must be made parallel by a collimator. (*Carl. Rep.*, xvi, 570; *J. Phys.*, April, 1881, x, 175.)

Lommel has described a new polarizing apparatus, in which two plates of magnesium platincyanide, cut perpendicularly to the optic axis, are used as polarizer and analyzer, as in the tourmaline pincettes. In the tourmaline, however, the ordinary ray is the one that is absorbed, while here it is the extraordinary ray; hence the tourmaline is cut parallel to the optic axis and the platincyanide perpendicular to it. The new apparatus transmits a blue light, which, when the angle of incidence exceeds  $2^\circ$ , is perfectly polarized in the plane of incidence. (*Wied. Ann.*, 1881, II, xiii, 347; *Nature*, July, 1881, xxiv, 294.)

Bertin has improved the tourmaline pincette by applying to it a part of the lenses of a polarizing microscope. The ordinary instrument can be used with only a limited number of crystals, by reason of the smallness of its field; but the new one shows well the fringes only 2 millimeters in diameter and  $\frac{1}{4}$  millimeter in thickness. All uniaxial crystals give fringes in it, and biaxial crystals can be observed when, as in the case of calamine, their axes are  $75^\circ 20'$  apart. (*J. Phys.*, March, 1881, x, 116.)

Whitwell has described a simple polarization experiment. If a plate of ice be broken off and held between the sky and a pool of water its reflected image will show color. The incident rays should come from the sky, about  $90^\circ$  from the sun, and reflection should take place at the polarizing angle for water. (*Nature*, January, 1881, xxiii, 268.)

Sörrensen has also observed some polarization phenomena with ice and water. The ice on a window pane had melted and the water formed a pool at the bottom, in which various bright and beautiful colors appeared. On examination they proved to be the grotesque images of the frost-flowers on the pane reflected in the water. The daylight itself was strongly polarized, which was attributed to the presence of a light mist of ice particles reflecting the sunlight. The temperature of the external air was about  $12^\circ$ . (*Nature*, March, 1881, xxiii, 442.)

Henri Becquerel has investigated elaborately the rotatory polarization of gases. He concludes (1) that the plane of polarization is rotated in gases under magnetic influence; (2) that the rotation is inversely as the square of the wave-length of the light used; (3) that the rotatory power can be compared to liquid carbon disulphide, and so to other liquids and gases, and (4) that oxygen shows anomalies, connected probably with its magnetic properties. (*Ann. Chim. Phys.*, November, 1880, V, xxi, 289; *Am. J. Sci.*, February, 1881, III, xxi, 139.)

Becquerel has since extended the above results, and now shows that even the earth's magnetism is strong enough to rotate the polarized ray. He finds that the rays D traversing horizontally a column of carbon disulphide one meter long undergo at the temperature  $0^\circ$  C., and at Paris, a magnetic rotation of  $0.8697'$ . (*C. R.*, September, 1881, xciii, p. 481; *Am. J. Sci.*, December, 1881, III, xxii, 484.)

## ELECTRICITY.

1. *Magnetism.*

Rowland has published a series of important papers on the general equations of electro-magnetic action with application to a new theory of magnetic attractions, and to the theory of the magnetic rotation of the plane of polarization of light, in which is contained the mathematical consideration of that action of magnetism on electric currents recently discovered by Mr. Hall, proving that if Maxwell's theory of light be true, the new action will explain the magnetic rotation of the plane of polarization. The new theory of magnetism supposes the magnetic field to consist of a perfect fluid whose velocity at any point is represented in magnitude and direction by the magnetic vector-potential at the point. The vortex lines in this fluid are the lines of magnetic induction, and the velocity of angular rotation is proportional to the magnitude of the magnetic force. As  $4\pi$  times the electric current is related to magnetic induction in the same way as magnetic induction to the vector-potential, Rowland considers that an electric current consists, as it were, of vortices of vortices; i. e., that certain irregular distribution of the vortices constitutes currents. (*Am. J. Math.*, ii, 334; iii, 89. See also *Nature*, June, 1881, xxiv, 204.)

Trowbridge has made experiments to determine the effect of great cold upon the magnetism of steel, showing that very low temperatures exercise a far greater influence on the magnetic condition than has hitherto been noticed. Wiedemann has stated that a steel bar magnetized at  $6^{\circ}$  or  $8^{\circ}$  C., lost only 4 per cent. on being cooled to  $-25^{\circ}$ ; but the author finds that a bar magnetized at  $20^{\circ}$  C. loses at  $-60^{\circ}$  66 per cent. of its magnetism. (*Am. J. Sci.*, April, 1881, III, xxi, 316.)

Pictet has examined a number of steels with reference to their magnetic power. He finds that this quality depends on the presence of carbon and on their state of aggregation. One of the two steels giving the best results had  $\frac{1}{2}$  of a per cent. of carbon; while samples having  $1\frac{1}{2}$  to  $1\frac{3}{4}$  were inferior. German steel made for springs, though of poor quality, made a good magnet. It had little homogeneity, and consisted of an intimate mixture of iron and iron cemented with a small proportion of carbon. (*Nature*, September, 1881, xix, 521.)

Sir William Thomson has taken advantage of the fact that the magnetism of steel changes with the temperature becoming weaker when warmed and recovering its strength on cooling, to construct what he calls a thermo-magnetic thermoscope. Two thin wires of hard steel, each one centimeter long, arranged so as to form a nearly astatic couple, place themselves at right angles to the magnetic meridian. Two other magnets of twice the size, placed one on each side of the astatic couple, act as deflectors. They are laid in a line nearly along the meridian, with their similar poles facing each other, and about two centimeters apart.

When the temperature of either of these deflectors changes, the little astatic pair turns through an angle, which, when small, is directly proportional to the temperature-difference. The deflections are read by a mirror and lampstand, as usual. (*Nature*, February, 1881, xxiii, 372.)

## 2. *Electromotors.*

Thomsen has experimented to determine whether the total quantity of heat which comes from the chemical reaction in a battery with two liquids corresponds wholly or only in part to the total heat set free in the circuit. The quantities of heat evolved in the chemical reactions in the Daniell cell he had previously determined to be 50130 heat-units. He now finds that the total quantity of heat evolved in the circuit during the decomposition of one equivalent of copper sulphate is 50292 units, a difference of only 0.3 per cent. For other batteries the results were the same whenever the surface of the negative electrode was not changed by the electrolysis. He concludes, therefore, that the whole of the chemical energy is employed in the production of electricity. (*Wied. Ann.*, II, xi, 246; *J. Phys.*, November, 1881, x, 502; *Am. J. Sci.*, January, 1881, III, xxi, 74.)

Kalischer has confirmed the observations of Adams and Day, that light may in certain cases set up in selenium cells a photo-electromotive force, the cell thus becoming its own battery. (*Nature*, October, 1881, xxiv, 593.)

Reynier has proposed a new form of battery, in which the zinc is immersed in a solution of sodium hydrate and the copper in a solution of copper sulphate. The resistance of the battery is lessened: 1st, by adding to the solutions suitable neutral salts; and, 2d, by placing the zinc with its solution in a porous cup made of parchment paper without seams. The electromotive force of the battery varies from 1.3 to 1.5 volts, and the resistance of a cell 2 decimeters high and of a capacity of 3 liters is 0.075 ohm. (*J. Phys.*, April, 1881, x, 160.)

The polarization of solids in contact with liquids has received a large share of attention. Helmholtz has published a paper on the currents produced by the motion of electrodes of polarized platinum. (*Wied. Ann.* xi, 737; *J. Phys.*, July, 1881, x, 320.) Blondlot has made an experimental research on the capacity of voltaic polarization. (*J. Phys.*, July, August, 1881, x, 277, 333.) Bartoli has sought to determine the electromotive force of polarization produced by the passage of a known current in a given electrolyte with given electrodes during a very short time. (*Il Nuovo Cimento*, III, vii, 234; *J. Phys.*, May, 1881, x, 218.)

This phenomenon of polarization has culminated in the production of storage batteries, or accumulators, as they are termed. Sir William Thomson has made several communications concerning one of these, devised by C. Faure, of Paris. It is essentially a Planté battery; but in place

of forming the lead oxide upon the surface of the lead plates themselves, as Planté has done, the two plates are covered with a layer of red lead held in place by a wrapping of felt. Reynier had said that one of these cells weighing 75 kilograms could store up sufficient energy to yield a horse-power of work for an hour. Thomson found the box of electricity brought to him at Glasgow from Paris by Major Seaver, occupying 72 hours in the trip, to contain in the space of one cubic foot a million foot-pounds of energy, thus confirming Reynier's statement. Accumulators weighing three-quarters of a ton will work for six hours from one charge, doing work all this time at the rate of one horse-power, with an economy of 90 per cent. (*Nature*, May–September, 1881, xxiv, 68, 105, 137, 156, 433, 491.)

Sutton has described a new electrical storage-battery, in which he uses a sheet of lead amalgamated and a sheet of thin copper a little shorter. The two sheets are perforated with a number of holes, and then rolled in a spiral separated by rubber bands. The plates are immersed in a solution of copper sulphate, the lead plate being made the positive electrode of a suitable source of electricity. The oxygen set free on the lead plate produces peroxide there, the hydrogen reduces the sulphate and deposits copper on the copper plate, the liquid becoming colorless. During the discharge of the battery these actions are reversed. A cell 4 inches deep and 4 inches in diameter heated one inch of No. 28 iron wire to bright redness for over two hours. (*Nature*, December, 1881, xxv, 198.)

Sir William Thomson read a paper at the York meeting of the British Association upon the proper proportions of resistance in the working coils, the electro-magnets, and the external circuits of dynamo-electric machines. In this paper he shows that in such a machine giving a continuous current the equation  $E = \sqrt{R R'}$  holds; in which  $E$  is the resistance of the external circuit and  $R R'$  are the resistances of the field-magnets and the revolving bobbins. If  $r$  represent the ratio of the total work to the lost work, and  $e = \frac{R'}{R}$  the formula  $r = 1 + 2\sqrt{e}$  results.

The dynamo considered in these calculations has its field maintained by a shunt circuit. (*Nature*, September, 1881, xxiv, 526; *C. R.*, September, 1881, p. 474; *Am. J. Sci.*, December, 1881, xxii, 484.)

The Pacinotti electro-magnetic machine, constructed in 1860 and described in 1864, has become interesting since the invention by Gramme of his ring armature. This machine was exhibited at the electrical exhibition in Paris, and the article from the Italian journal, in which it first appeared, has been republished in several of the electrical journals. (*Il Nuovo Cimento*, June, 1864, xix, 378; *L'Electricien*, November, 1881, ii, 127; *J. Phys.*, November, 1881, x, 461.) Another machine with a ring armature was exhibited in the Holland section as having been made by Elias in 1842. But beside the ring armature in six sections, and the commutator in six pieces, there is no correspondence between this and the Gramme machine, the connections being made quite differently. (*L'Electricien*, November, 1881, ii, 125.)

3. *Electrical measurements.*

Stoletow, in a communication to the French Physical Society, has described an apparatus for determining the ratio of the electrostatic to the electromagnetic unit of quantity. It consists of an absolute condenser, consisting of two metal disks accurately plane, the upper furnished with a guard-ring. By means of three microscopes, the distance between the plates can be accurately measured. This condenser is charged by a battery, and the discharge current is compared with the constant current produced by the same battery in a circuit of known resistance. In order not to require too large a battery, a series of discharges of known number per second is passed through the galvanometer by means of a commutator, thus producing the effect of a constant current and requiring only one Daniell cell. The first results with the apparatus were satisfactory. (*J. Phys.*, November, 1881, x, 468.)

Rayleigh and Schuster have employed the original apparatus used by the British Association Committee, for the purpose of redetermining the value of the ohm in absolute measure. They have obtained the value 0.9893 earth-quadrants per second, that obtained by Rowland being 0.9911. (*Proc. Roy. Soc.*, xcii, 104, 141; *Am. J. Sci.*, December, 1881, III, xxi, 484.)

Fleming has devised a new form of resistance coil, constructed with a view to avoid the leakage due to condensed moisture on the paraffin insulating the electrodes, and at the same time to facilitate equalization of temperature. The wire is wound bare, each layer being separated from the others by strips of ebonite notched to receive the turns, and the whole is inclosed in a brass box screwed together. (*Nature*, June, 1881, xxiv, 183.)

Kohlrausch has simplified the apparatus required for his method of measuring resistance, by means of alternating currents. The currents are now produced by an induction coil; and, in place of an electro-dynamometer, the telephone may be used. For liquids, large electrodes of platinized silver are employed. (*Wied. Ann.*, II, xi, 653; *J. Phys.*, April, 1881, x, 173.)

Fleming has described a new form of resistance balance, adapted for comparing standard coils, and used by him for measuring coils made of wires of different alloys. A platinum iridium wire  $\frac{3}{32}$  inch diameter, 39 inches long, and of a total resistance of 0.0512 ohm, is let into the face of a horizontal disk of ebonite, but not flush with the surface; so that a knife-edge of the same metal carried on an arm moving about the center of the disk may be put in contact with it. The edge of the disk is graduated into 1,000 parts, and by a vernier on the alidade 0.1 of a division can be measured. This apparatus is used in a Wheatstone's bridge, two of the other resistances being auxiliary coils of nearly the same resistance each. The two coils to be compared are connected, each with one of the two poles of the battery, and each with one of the two ends of the circular wire. The galvanometer wire connects the point of



union of the first two coils with the axis which carries the alidade. This arm is so placed that the galvanometer is at zero, and the reading is noted. The two coils are then reversed in position, and a second reading taken. The difference is the difference in their resistance. Were it not for changes of temperature, measurements could be made to the  $\frac{1}{100000}$  of an ohm. (*Phil. Mag.*, V, ix, 109; *J. Phys.*, March, 1881, x, 135.)

Glazebrook has called attention to an error which results when small resistances are measured by the Wheatstone's bridge, due to thermoelectric forces which have their seat at the point of contact of the copper and the platinum of the apparatus. The result is that the resistances found seem to depend on the resistance of the battery. They are eliminated by reversing the battery current. (*Phil. Mag.*, April, 1881, V, xi, 291; *J. Phys.*, November, 1881, x, 500.)

Minchin has given an account to the London Physical Society of his new sine electrometer. It consists of two metal plates, in one of which is an aperture nearly closed by a metal trap-door, suspended from the plate by two fine platinum wires, and when the plates stand vertical, resting against fine stops. These plates are connected to the poles of the cell to be measured, and tilted out of the vertical till the attraction of the whole plate on the suspended trap or shutter is just balanced by the weight of the latter. Then the electromotive force is proportional to the sine of the angle of displacement. (*Nature*, May, 1881, xxiv, 95.)

Mascart has modified the quadrant electrometer of Thomson, reducing materially its size, and adapting it to the purpose of meteorological registration by means of photography. The quadrants are kept charged by a few cells of water-battery, and the water-dropping collector, used to obtain the atmospheric potential, is in communication with the needle, the case being connected with earth. The same photographic devices have been employed to record magnetic variations, the horizontal force being given by a bifilar magnetometer, the vertical force by a magnetic balance, and the declination by a declinometer, all the tracings being obtained upon a single sheet of paper. (*J. Phys.* June, 1881, x, 229.)

Baille has employed the torsion balance to measure electromotive forces, and has obtained results agreeing well with those made by other methods. (*Ann. Chim. Phys.*, June, 1881, V, xxiii, 269.)

Pellat has studied the discharge of a condenser by means of a telephone. With reference to the current necessary to give an audible sound in the telephone, he says: "Experiment has shown me that the energy corresponding to a calory, that is, to the amount set free by a gram of water cooled  $1^{\circ}\text{C}$ ., transformed into electricity and sent through the telephone, will produce a continuous and clearly perceptible sound for ten thousand years!" (*J. Phys.*, August, 1881, x, 358.)

Edison has contrived several forms of an instrument for measuring electrical currents, which he calls a "webermeter." In the form to be

used in registering the current for domestic lighting, there are two cells through which a shunted portion of the current flows, in one several times that in the other. In these cells are plates of copper immersed in sulphate of copper solution. These are weighed every month, and from the increase in weight the quantity of the current which has passed through the cell is given. This, multiplied by the shunt, gives the total current in the house for the time. In the second and more delicate form two copper plates are suspended in an electrolytic cell containing copper sulphate from the arms of a balance. The apparatus is placed in a shunted circuit, say, of  $\frac{1}{1000}$ . By the action of the current copper is dissolved off one plate and deposited on the other. The heavier one falls to a certain point, then automatically reverses the current. The other side now becomes heavier and goes down, and the current is again reversed. The beam thus oscillates, and its oscillations are registered on a dial. By properly adjusting its parts each tip may be made to correspond with a definite quantity of current. By combining the delicacy of the mirror method with a delicately constructed weber-meter, Edison has been able to measure in one minute a current so slight that it would deposit only ten milligrams of copper in the course of a century. (*Cat. Gen. Off., Paris Exh.*, 162; *Nature*, July, 1881, xxiv, 294.)

Brackett has described a new form of galvanometer for powerful currents, based on the tangent-galvanometer principle. Two rings of copper or brass are turned so that the one passes within the other. They are then both cut on one side, the smaller placed within the larger, one of the ends of each united firmly by a metal plate, and pieces of vulcanite put between the rings to make them concentric. The other ends of the rings and the united ends are attached to three binding-screws. The instrument may be used as an ordinary-tangent galvanometer with either of the rings, or, by combining, them it may act differentially on the needle, owing to the different distances of the rings. The instrument works well in practice. (*Am. J. Sci.*, May, 1881, III, xxi, 395.)

#### 4. *Electric spark and light.*

Deprez has applied to the induction coils made by Carpentier a new form of interrupter, designed by himself. From his study of the action of the coil he concluded (1) that the current should be broken as soon as the maximum magnetism is attained in the core; and (2) that it should be re-established as soon as possible thereafter. (*J. Phys.*, August, 1881, x, 360.)

Bottomley has described some curious experiments with vacuum tubes. The tubes are exhausted very completely and sealed up without electrodes. If one end of a long tube like this be applied to the prime conductor of an ordinary frictional machine, the other end being held in the hand, the tube becomes charged as a double Leyden jar, the end next to the machine being positive without and negative within; while

the other end is positive inside and negative without. The charges are very high and the glass is frequently perforated. If discharge is effected by alternate contact of the ends beautiful luminous effects are seen in the tubes. (*Nature*, January, 1881, xxiii, 218.)

Preece has discussed the relation which exists between the length of a lightning conductor and the space which it protects. He assumes the data of De la Rue and Müller, that to produce a spark one centimeter long in air requires a difference of potential of 40,000 volts, and concludes that a lightning-rod protects a conical space whose height is the length of the rod whose base is a circle having its radius equal to the height of the rod, and whose side is the side of a circle whose radius is equal to the height of the rod. (*Phil. Mag.*, Dec. 1880, V, x, 427; *Am. J. Sci.*, February, 1881, III, xxi, 141.)

Leconte has observed that these conditions laid down by Preece are to be regarded as minimum conditions, because the use of pointed conductors would certainly increase very considerably the area protected. (*Nature*, February, 1881, xxiii, 386.)

Jamin has examined the counter-electromotive force developed in the arc. This electromotive force is equal to 20 or 25 volts; so that the principal work of maintaining the arc appears to be spent in overcoming this opposing force, and is not occasioned by the resistance of the arc itself, which is small. This forms the difficulty of maintaining many arc-lights in the same circuit with batteries, continuous current machines or accumulators; but with alternate current machines with a certain speed, this counter-electromotive force reaches a minimum. It appears to be due to the difference of temperature between the carbons, and as this difference disappears when alternate currents are used, the inverse electromotive force is diminished. (*C. R.*, May, 1881, xcii, 1021; *Am. J. Sci.*, July, 1881, III, xxii, 74.)

Nipher has shown that the statement by Preece, that the quantity of heat evolved in each of the electric lamps contained in the same circuit varies as the inverse ratio of the square of the number of lamps, is true only in the special case which he considers. If the lamps be arranged in parallel circuits, each circuit containing a certain number of lamps, the total quantity of heat produced in the lamps is independent of the number of lamps, the quantity of heat in each lamp varying inversely as their number. (*J. Phys.*, February, 1881, x, 94.)

Avenarius has patented a method of subdividing the electric light, founded on the insertion of a polarizer in a secondary circuit connected with each electric lamp. This polarizer consists of several voltmeters connected together. The current from the machine divides at the lamp; one part goes through it, while the other goes through the polarizer. The intensity of the light in the lamps may be varied by inserting resistance in the polarizers, and by increasing the number. The individ-

ual lamps are independent of each other, and lamps of different systems may be used simultaneously. (*Nature*, February, 1881, xxiii, 373.)

Sir William Thomson communicated to the British Association at York the results of measurements made by himself and by Bottomley upon the illuminating power of incandescent vacuum lamps. The lamps used were of the Swan pattern, and the current was furnished by Faure secondary batteries. The electromotive force at the terminals of the lamp was determined by a galvanometer of very high resistance; the current strength by one of low resistance; and the candle-power by comparing the shadows of a pencil cast by the lamp and by a standard candle on a sheet of white paper. With 26 cells the electromotive force was 56.9 volts, the current 1.21 webers, and the candles 11.6; thus giving 6.88 kilogram-meters per second for the work done in the lamp, or 0.093 horse-power. This would give 125 candles per horse-power of current. At 25 candles the economy rose to 194 candles per horse-power; at 38 to 224 candles per horse-power; at 55 to 294 candles; at 82 to 349; at 102 to 382; at 117 (another lamp) to 316; at 189 to 440. Lamp No. 1 gave at 66 candles an economy of 295; No. 2, at 68 candles, one of 234; and No. 3, also at 68, one of 219 candles per horse-power. (*Nature*, September, 1881, xxiv, 490.)



## CHEMISTRY.

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### GENERAL AND PHYSICAL.

Williamson, in an address before the Chemical and Physical Society of University College, London, discussed what he called an error in the commonly received theory of chemistry. There is a division of opinion on the question of variable equivalence; by one class of chemists nitrogen in ammonium chloride being considered quinquivalent, and by another ammonium chloride being regarded as molecular: *i. e.*, the force uniting the compound together, according to the former, is atomic or chemical; according to the latter, it is physical. The author thought we had no grounds for assuming a difference between chemical and physical force. Kekulé's theory, that an atom had only one valence, was no longer tenable; nor, in his opinion, was the view that the valence varied within narrow limits. He knew of no limitation to atomic value. Contrary to what is often asserted, that the valence of an element was independent of the nature of the elements with which it is combined, we know that the character of these atoms materially affects the result. Thus, gold, which alone could combine with no more than three chlorine atoms, can take up an additional one if an atom of sodium be supplied at the same time. The atomic value of an element depends upon the nature of the combining atoms, and upon the temperature also. (*Nature*, November, 1881, xxv, 21.)

Perkin has obtained two series of compounds in his researches on coumarine, differing in properties, but generally convertible the one into the other by the action of the heat. He thinks that the ordinary theory of isomerism, according to which this phenomenon is traceable to the occupation of different relative positions by the atoms in two molecules, fails to explain the cases of isomerism now described by him. He favors the view that the atoms in the molecules of any pair of the newly-described compounds occupy the same relative positions, but are at different absolute distances from each other. It should be remembered, however, that the present theory of isomerism is applicable only to gaseous molecules; the molecular phenomenon of liquid and solid bodies are too complex to find as yet any general explanation. Perkin's

new compounds seem to belong to the rapidly increasing class of "physical isomers," *i. e.*, liquid or solid bodies whose chemical properties are to be traced to the binding together of molecular groups, the individual members of which occupy relatively different positions, the groups themselves acting as chemical units. The molecular volumes of metamers do not favor the hypothesis proposed by Perkin. (*J. Chem. Soc.*, August, 1881, xxxix, 409; *Nature*, October, 1881, xxiv, 542.)

The rate at which chemical changes progress has been studied by Kayander. He used magnesium plates about 2,000 square millimeters in surface, immersed in various acids, the solutions containing 0.01 of the molecular weight in grams in the liter of water. As to the influence of time, he concludes that the reaction begins at the very moment the plate is immersed, the same action taking place when two acids are mixed. The influence of temperature is precisely that exercised by it on the diminution of the internal friction of the particles of the liquid against each other. It does not seem to influence at all the chemical properties of the reacting bodies. His figures show that the velocity of the reaction is inversely proportional to the internal friction of the medium. (*Nature*, June 1881, xxiv, 112.)

Berthelot has stated that the chemical change which occurs when an acid soluble in water acts on a soluble base or salt, or *vice versa*, or when two soluble salts mutually react, is completed in a time not appreciably greater than is required for completely mixing the two solutions. (*Nature*, February, 1881, xxiii, 373.)

Thorpe has called attention to some cases of chemical reaction taking place between solids. Thus, when perfectly dry potassium iodide and mercuric chloride, or lead nitrate, or silver nitrate and potassium chromate are rubbed together in a mortar, the characteristic color of the reaction appears. (*Nature*, September, 1881, xxiv, 467.)

Dewar has discussed the question of the alleged decomposition of the elements in a paper read at York. He concludes thus: "The supposition that the different elements may be resolved into simple constituents and even into a single substance, had long been a favorite speculation with chemists; but however probable that hypothesis may appear *a priori*, it must be acknowledged that the facts derived from the most powerful method of analytical investigation yet devised give it but scanty support." (*Nature*, September, 1881, xxiv, 468.)

Strecker has found that for chlorine, bromine, and iodine in the gaseous state, the ratio of the kinetic energy of the progressive motion of the molecules to the total energy is different from that observed with other diatomic gases. These bodies seem therefore to form a group by themselves, their molecules seeming to have a different reciprocal action. The author doubts the validity of the suppositions of both Maxwell and Boltzmann as to the nature of the mobility of the atoms in the gaseous molecule. (*Wied. Ann.*, 1881, II, xiii, 202.)

Thomsen has sought to throw some light on the molecular structure

of hydro-carbons from thermo-chemical investigations. For the fatty series the structure generally adopted is regarded as correct. But in the aromatic series, he concludes against the constitution as expressed by Kekulé's formula, and says: "The six carbon atoms of benzene are united to each other by nine single bonds; and the previous assumption of a structure of benzene with three single and three double bonds, is not supported by experiment. (*Ber. Berl. Chem. Ges.*, January, 1881, xiii, 1321, 1388, 1806; *Am. J. Sci.* February, 1881, III, xxi, 87.)

Thomsen has endeavored to show that the molecular rotation (*i. e.*, the product of the rotatory power by the molecular weight divided by 100,) is for many classes of bodies a simple multiple of a constant number. This constant for a large class of bodies is 0.95; this multiplied by 4 gives 3.8, the constant for the family of alcohols, and by 9 gives 8.65 the amide family constant. (*Ber. Berl. Chem. Ges.*, January, 1881, xiii, 2168, 2264, 2266, 2269.)

Brühl has advanced the hypothesis that the molecular refraction of isomeric carbon compounds is constant only when they contain singly-linked carbon atoms, and hence variations in this constant must be due to variations in the manner of linking. Janowsky, however, has maintained that slight differences are always noticeable between the molecular refractions of isomeric compounds where the grouping of the carbon atoms and not the linking is the cause of the isomerism. (*Ber. Berl. Chem. Ges.*, January, 1881, xiii, 1520, 2415; *Nature*, February, 1881, xxiii, 374.)

#### INORGANIC.

Valente has shown the replacement of iodine by chlorine in a striking form for a lecture experiment, as follows: A jar of 500 cubic centimeters capacity is filled with dry hydrogen iodide gas, and another of 250 cubic centimeters capacity with dry chlorine, the larger jar being placed above the other, with a glass plate between them. On withdrawing the plate decomposition occurs with a flash of rose-colored flame, and iodine is deposited. (*Nature*, July, 1881, xxiv, 293.)

Allary and Pellieux have proposed to evaporate to dryness the mother liquors used for the preparation of iodine, to roast, to extract with cold water and again evaporate, to extract the residue with alcohol, to distill off the alcohol, to add potassium carbonate, to pass carbon dioxide gas through the solution, and to crystallize out pure potassium iodide. (*Bull. Soc. Chim.*, II, xxxiv, 627; *Am. J. Sci.*, February, 1881, III, xxi, 136.)

Hautefeuille and Chappuis have observed that when oxygen is converted into ozone by the silent discharge, a low temperature greatly augments the yield. Thus at 760 millimeters a temperature of  $-23^{\circ}$  gave 0.214 by weight of ozone, and at 180 millimeters pressure 0.181. Mixed with four vols. of nitrogen at this temperature, the ozone was increased to 0.216, and to 0.240 when two vols. N. were present. On cooling the ozone by methyl-chloride, and compressing it in a Caillietet's apparatus, an azure-blue color appeared in the tube, becoming indigo-blue at sev-



eral atmospheres; cooling to  $88^{\circ}$  the color became three or four times darker. Indeed a tube a meter long, filled with the ozonized oxygen at the ordinary pressure, showed a sky-blue color when looked through at a white surface. By adding carbon dioxide, and then compressing, a blue liquid layer was obtained not differing in shade from the gas above it. Moreover, on compressing the products of the silent discharge upon carbon dioxide, the blue color developed and the excess of  $\text{CO}_2$  liquified and became blue. (*Bull. Soc. Chim.*, January, 188, III, xxxv, 2; *Am. J. Sci.*, March, 1881, III, xxi, 233.)

Claesson has shown that when ferric chloride is added to a solution of a sulphhydrate a deep red color is produced, varying from red-brown to red-violet. (*Ber. Berl. Chem. Ges.*, March, 1881, xiv, 411.)

Bernthsen has examined the composition of sodium hyposulphite. By converting it into sulphate by means of iodine, determining both the iodine used and the sulphuric acid formed, it appeared that each sulphur atom in the hyposulphite required three atoms of iodine to convert it into sulphuric acid. The state of oxidation in this acid is therefore represented by the formula  $\text{S}_2\text{O}_3$ . From the estimation of the ratio of bases present, there appeared to be one of base to one of sulphur. While the simplest formula would be  $\text{NaSO}_2$ , the author thinks the dibasic character of the sulphur acids requires a doubling of the formula,  $\text{H}_2\text{S}_2\text{O}_4$ . (*Ber. Berl. Chem. Ges.*, March, 1881, xiv, 438.)

Johnson has observed the direct synthesis of ammonia by passing a mixture of nitrogen and hydrogen gases over hot spongy platinum, to the extent of 24 milligrams per hour in one experiment. But if the nitrogen before mixing with the hydrogen be passed through a red-hot tube, the formation of ammonia is entirely arrested. This the author thinks is proof that nitrogen exists in an active and inactive state, the latter produced from the former by heat. (*J. Chem. Soc.*, March, 1881, xxxix, 128.)

Warrington has confirmed a statement made by Schönbein that nitrite of ammonium is produced whenever water is evaporated. Since no nitrous acid was produced when the evaporation was conducted in close vessels, the air must be the source of the contamination. A liter of water evaporated over a gas-jet gave  $\frac{1}{10}$  milligram of nitrogen, while a second liter evaporated by steam gave only  $\frac{1}{150}$  milligram; hence the combustion of the gas produced nitrous acid; but on exposing a third liter of water to the air for the time required for the evaporation of the second, the nitrous acid reaction was obtained. For ordinary purposes water may then be evaporated in a steam bath, but for extremely accurate work the evaporation must be done in close vessels. The test used was the naphthylamine test proposed by Griess, which is delicate enough to show one part of nitrogen as nitrous acid in one thousand million parts of water. (*J. Chem. Soc.*, May, 1881, xxxix, 229.)

Kraut has experimented to settle the question whether nitric acid will ignite ordinary combustibles. A wooden box filled with straw, saw-

dust, hay, or shavings has 25 to 100 c. c. of nitric acid of 1.5 specific gravity placed in the center. Vapors become visible in a minute or two, a thick white smoke appears, and then the odor of burning material is perceptible. In five or six minutes the box is opened and is found filled with a burning mass which bursts into flame on access of air. (*Ber. Berl. Chem. Ges.*, February, 1881, xiv, 301.)

Berthelot has observed that when the silent discharge acts on a mixture of oxygen and nitrogen tetroxide, the gas becomes decolorized; but that on ceasing the discharge, slow decomposition took place, reproducing the orange vapor. Since exposure to a freezing mixture produced no crystals, it was not nitric oxide  $N_2O_5$ . Moreover, the spectroscope gave characteristic absorption bands. Hence the author supposes it to be pernitric oxide. (*Ann. Chim. Phys.*, March, 1881, V, xxii, 431.)

Jones and Taylor have described a colorless gas with a characteristic and extremely disagreeable odor, producing nausea and headache, which they have obtained by the action of hydrogen-chloride upon magnesium-boride. The gas is slightly soluble in water, burns with a splendid green flame, producing boric oxide, deposits boron in a heated tube through which it is passed, or on a porcelain plate held in its flame, gives a black precipitate in a solution of silver nitrate, and gives on analysis numbers confirming the formula  $BH_3$ . It is therefore boron hydride. (*J. Chem. Soc.*, May, 1881, xxxix, 213.)

Chappuis has confirmed earlier suggestions that the luminosity of phosphorus is due to ozone. In pure oxygen at  $15^\circ$ , under atmospheric pressure, phosphorus is not luminous in the dark, but a bubble of ozone admitted produces the luminosity at once, though only momentarily. Two cylinders, one containing air the other pure oxygen, were inserted over potassium iodide and starch solution. A fragment of phosphorus was placed in each jar. The luminosity appeared in the first and the liquid became blue, but neither phenomenon appeared in the second. Whenever the phosphorescence appeared ozone was present; when ozone was absent there was no luminosity. Again, those bodies which prevent the luminosity of phosphorus, such as turpentine, for example, are precisely those which destroy ozone or are destroyed by it. The author regards the production of the luminosity of phosphorus in oxygen as one of the most delicate of the reactions of ozone. (*Bull. Soc. Chim.*, April, 1881, II, xxxv, 419.)

A new variety of coal, said to be the richest in carbon of any member of the coal series yet discovered, has been found near Scheunga, on the western shores of Lake Onega. It contains 91 per cent. of carbon, 7 to 8 per cent. of water, and 1 per cent. of ash. It is extremely hard and dense, has an adamantine luster, is a good conductor of electricity, and has a high specific heat, 0.1922. Though the carbon is as high as in the Ceylon graphite, it is not a graphite, since its behavior with potassium chlorate and nitric acid is that of an amorphous coal. (*Nature*, June, 1881, xxiv, 204.)

The detection of small quantities of carbonous oxide may be effected in a room, for example, by drawing the air over powdered glass moistened with diluted blood, shaking the blood with a drop of ammonium sulphite, and examining by the spectroscope. Strips of paper moistened with a solution of 0.2 gram palladium chloride in 100 cubic centimeters water may be used to detect this gas. If the dried slips are hung in a flask on a wire of platinum, the flask containing a little water, and corked, black, shining deposit of metallic palladium appears on the paper in a few minutes, if five parts of carbonous oxide be present. If only one part be present, from 2 to 4 hours are required. If only half a part, from 12 to 24 hours. (*Nature*, June, 1881, xxiv, 112.)

Hawes has examined the liquid contained in the cavities of the smoky quartz from Branchville, Conn. This quartz is so full of cavities containing condensed gas that a report like the explosion of a percussion cap takes place when a fragment is knocked off with a small hammer. When heated it decrepitates with such violence that bits fly whistling through the air to a distance of twenty feet. The cavities contained water, liquid carbon dioxide, and its gas, as was proved by the disappearance of the liquid at  $31^{\circ}\text{C}$ , the critical point for  $\text{CO}_2$ . Moreover, the cavities were large enough and sufficiently numerous to enable an analysis of their contents to be made by Wright, who found the gaseous contents to consist of  $\text{CO}_2$  98.33, N 1.67, and  $\text{H}_2\text{S}$ ,  $\text{SO}_2$ ,  $\text{H}_3\text{N}$ , F and Cl traces. The water present was in general 69.02 per cent. of the entire inclosure approximately. Hawes accounts for the rapid motion observed in some of their cavities by the alternations of evaporation and condensation produced by minute changes of temperature. (*Am. J. Sci.*, March, 1881, III, xxi, 203, 209.)

Monnier has presented to the Physical Society of Geneva an ingenious apparatus, called an automatic methanometer, or fire-damp indicator, designed for use in mines. The fire-damp in presence of air in excess is decomposed in a glass vessel by an incandescent platinum wire, and the change of volume produced acts directly on a mercury manometer with platinum contacts. Every hour or half hour the air of the mine is forced into the burner by a bellows, automatically. The result of the test is registered, also automatically, in the central office. (*Nature*, June, 1881, xxiv, 112.)

C. W. Siemens has read a paper before the Birmingham meeting of the British Association of gas managers on the use of gas for heating and lighting purposes, in which he maintained the need of improved processes in the manufacture of gas, so as to produce a gas of higher illuminating power, and of improved burners, giving a higher temperature of combustion, and therefore more light. He also advocated a separate supply system of gas for heating purposes. (*Nature*, June, 1881, xxiv, 153.)

Remsen has shown that when a mixture of iron by hydrogen, potassium-sodium tartrate and metallic sodium is heated in a combustion

tube, and nitrogen passed over the mixture, a cyanide is formed, which, treated in the usual way, gives the Prussian blue reaction. In general he states that when iron by hydrogen and certain non-nitrogenous organic substances are heated with metallic sodium in an atmosphere of nitrogen, a cyanide is readily formed. (*Am. Chem. J.*, May, 1881, iii, 134.)

Allary has proposed a simple and effective mode of purifying carbon disulphide, which consists in covering it with a layer of water, adding concentrated solution of potassium permanganate and agitating; repeating the operation so long as the color is discharged. After washing, it is freed from water and filtered, distillation not being necessary. It should be kept in the dark. (*Bull. Soc. Chim.*, May, 1881, II, xxxv, 491.)

Schützenburger and Colsen have described several new compounds of silicon. When crystalline silicon is strongly heated in a current of carbon dioxide the compound  $(\text{SiCO})_x$  is produced. When nitrogen is passed over a hot mixture of silicon and carbon  $(\text{Si}_2\text{C}_2\text{N})_x$  is formed. These bodies the authors regard as the oxide and the nitride respectively of the radical carbo-silicon  $(\text{Si}_2\text{C}_2)_x$ . Silicon nitrate  $(\text{Si}_2\text{N}_3)_x$  is also described. (*Nature*, October, 1881, xxiv, 542.)

Huntington has applied the method of Cooke in the determination of the atomic weight of antimony to the metal cadmium. From the first series of experiments, the atomic weight 112.31 was obtained as a mean, and from the second 112.32. (*Am. J. Sci.*, August, 1881, III, xxii, 148.)

Mallet has redetermined with great care the atomic weight of aluminum. His paper, published in full by the Royal Society, is an admirable example of a thorough scientific research. Three methods were employed: 1st, the ignition of pure ammonia alum; 2d, the precipitation of aluminum bromide by silver; and, 3d, the evolution of hydrogen by the action of aluminum upon sodium hydrate. The greatest care was taken in obtaining pure materials and pure reagents; all the operations were conducted with special regard to the elimination of error, and all reductions were made to vacuo. The results were: 1st method, series A, gave  $27.040 \pm .0073$  as a mean of 5 experiments; series B,  $27.096 \pm .0054$ , also a mean of 5. 2d method, series A,  $27.034 \pm .0049$ ; series B,  $27.023 \pm .0052$ ; series C,  $27.018 \pm .0069$ ; A and C from 3 experiments, and B from 5. 3d method, series A,  $27.005 \pm .0033$ , 6 experiments; series B,  $26.990 \pm .0046$ . As a mean of the whole, the atomic weight is  $27.032 \pm .0045$ . But if 1 B be excluded,  $al = 27.019 \pm .0030$ . Of the 18 elements whose atomic weights have been carefully determined, ten approach to whole numbers within less than a tenth of a unit. (*Phil. Trans.*, 1880, p. 1003; *Am. J. Sci.*, April, 1881, III, xxi, 321.)

Bibart has investigated the conditions under which iron becomes passive. As a result he concludes that the passivity of iron is not due to a layer of an insoluble subnitrate, still less to a layer of nitrogen dioxide, as has been supposed; but it is produced by any cause which

tends to oxidize the iron and destroyed by any cause which tends to deoxidize it. At the outset the passivity appears to be due to the simple layer of oxygen which is condensed on its surface; but gradually a layer of oxide forms and the passive condition is more permanent. (*J. Phys.*, May, 1881, x, 204; *Nature*, July, 1881, xxiv, 249.)

Seubert has redetermined with great care the atomic weight of platinum. The chloride prepared from the pure metal was precipitated by the chlorides both of potassium and of ammonium, four different processes being followed. The products were then analyzed. The results by the platinum determinations were 194.68495, 194.03928, 194.66507, 195.03374; by chlorine estimation, 195.33013 for the ammonium salt, and for the potassium 194.39190, 194.49368, 194.63088, or 194.62003. After making the necessary corrections and reduction to *vacuo* the value becomes 194.34050. (*Lieb. Ann.*, February, 1881, cxxvii, 1.)

#### ORGANIC.

Lunge and Steinkauler have obtained a new hydro-carbon from the stems and twigs of *Sequoia gigantea* Torr. On distilling the needles with water, agitating the distillate with ether, removing the excess of ether, and distilling, a solid substance was obtained, soluble in alcohol, ether, benzine, and chloroform, less readily in naphtha, and in glacial acetic acid only on heating. By covering its solution in this acid with water the gradual solution of the acid caused the new body to separate in small crystal plates, which fused at 105°, were white with a bluish fluorescence, and possessed the penetrating odor of the Sequoia in a high degree. It boiled between 290° and 300°, and, on analysis, it afforded the formula  $C_{13}H_{10}$ . The authors give it the name sequoiene. (*Ber. Berl. Chem. Ges.*, September, 1880, xiii, 1656; *Am. J. Sci.*, January, 1881, III, xxi, 68.)

Michaelis and Schulte have succeeded in the preparation of a body of analogous constitution to azo-benzene, but in which arsenic takes the place of nitrogen. The new compound is produced by acting with reducing agents, preferably phosphorous acid, upon an alcoholic solution of phenyl-arsenous oxide,  $C_6H_5AsO$ . Before the temperature has reached the boiling-point of the alcohol, the whole liquid solidifies to a mass of crystals, which, when drained and dried over sulphuric acid, are pure. Its formula is  $C_6H_5As=AsC_6H_5$ , corresponding to azo-benzene  $C_6H_5N=NC_6H_5$ , and phospho-benzene  $C_6H_5P=PC_6H_5$ . Naphthyl-arsenous oxide treated in the same way gives an analogous arseno-naphthalene  $C_{10}H_7As=AsC_{10}H_7$ . (*Ber. Berl. Chem. Ges.*, April, 1881, xiv., 912.)

Bechamp has studied the production of chloroform by the action of calcium hypochlorite upon alcohol in the ordinary way. From his experiments he concludes that the first action of the hypochlorite is an oxidizing one, oxidizing the alcohol to aldehyde. Then the second action produces from the aldehyde chloral and calcium hydrate; and, finally, under the action of the lime, the chloral breaks up into calcium

formate and chloroform. After the chloroform has all distilled off the mixture swells up and evolves oxygen. (*Ann. Chim. Phys.*, March, 1881, V, xxii, 347.)

Müntz has stated, as a result of his investigations, that all natural waters, whether rain, river, snow, or sea water, contain traces of alcohol. He describes his method of applying the iodoform test for alcohol, whereby one part can be detected in a million parts of water. (*Nature*, April, 1881, xxiii, 616.)

Kiliani has made an elaborate study of inulin, the starch of the artichoke. It appears to stand in very intimate chemical relations with levulose, probably the anhydride of it. It passes into levulose simply by warming for some time the water in which it is contained. It is distinguished from levulose by the fact that the latter reduces the copper test and ferments, while the former does neither. Dextrose, when oxidized, yields compounds having six atoms of carbon, while levulose affords bodies containing less carbon. This the author accounts for by supposing dextrose to be the aldehyde of mannite, and levulose its ketone. (*Lieb. Ann.*, ccv, 145; *Am. J. Sci.*, February, 1881, III, xxi, 138.)

Musculus, in conjunction with Meyer, has succeeded in reconvertng dextrose back into dextrin. Twenty grams pure dextrose were treated with thirty of concentrated sulphuric acid in small portions, 800 parts of alcohol were added, the solution filtered and allowed to stand 8 days. The abundant precipitate, when washed and dried, weighed ten grams, and was a white amorphous powder. It proved to be the alcoholate of dextrin, and on preparing the hydrate it possessed all the physical, chemical, and organoleptic properties of a dextrin. (*Bull. Soc. Chim.*, April, 1881, II, xxxv, 368.)

Scheibler has studied the new derivative of glucose discovered by Peligot, and called saccharin, and which has the formula  $C_{12}H_{22}O_{11}$ . It was prepared by boiling the solid starch sugar of commerce with dilute milk of lime so long as lime salts separate. The liquid is freed from lime, filtered, evaporated to a sirup, and allowed to crystallize. It expels  $CO_2$  from  $CaCO_3$  to form calcium saccharinate; but on removing the lime, the saccharinic acid splits into saccharin and water. Saccharin is dextro-rotatory, while its salts are lævo-rotatory. (*Ber. Berl. Chem. Ges.*, December, 1880, xiii, 2212.)

Roscoe, in a lecture in the Royal Institution on Baeyer's synthesis of indigo-blue, has stated that in 1879 the value of the indigo imported into Great Britain was two million pounds sterling, the total production of the world being twice that sum in value. The artificial paste which yields indigo-blue on reduction, and which contains 25 per cent. dry acid, is furnished at 6 shillings per pound. Though the price of the artificial cannot yet equal that of natural indigo, yet it has advantages which more than counterbalance this difference in price. (*Nature*, July, 1881, xxiv, 227.)

Grimaux has succeeded in producing the alkaloid codeine, by the action of methyl iodide in presence of sodium upon an alcoholic solution of morphine. Its properties are identical with those of the natural codeine. If ethyl iodide be used in place of the methyl compound, a new alkaloid, a homologue of codeine is produced. The author proposes the term codeines for the class, codomethyline, codethyline, etc., for the individual members of it. (*C. R.*, May, 1881, xcii, 1140, 1228.)

## BOTANY.

BY PROF. WILLIAM G. FARLOW.

During the year 1881 there has been great activity in the department of vegetable physiology, arising from the appearance of Darwin's *Power of Movement in Plants*, which, although announced in 1880, was not in reality known to the botanical public until 1881, but which has since its appearance been the subject of numerous important communications and discussions; from the discussions on the nature and action of chlorophyl excited by the publication of Pringsheim's researches on chlorophyl; and from the discussions of Schimper, Naegeli, and Meyer on the mode of growth and formation of starch grains, of Pfeffer, Boehm, and others on the cause of the movement of water in plants, and other questions of primary importance in the economy of plants.

Publications on vegetable anatomy, except so far as it relates to the structure of the vegetable cell itself, have not been very numerous. In cryptogams there may be said to have existed a mania for the formation of systems of classification. The paper of De Bary on *Saprolegniae* and *Peronosporae*, and the papers of Brefeld, figure among the more important works on the development of fungi, while descriptive works on both algæ and fungi have been numerous and important. On the higher cryptogams and phænogams the works published have been less numerous and of less magnitude than usual, although several notable contributions have been made. In this country considerable activity has been shown, and the proportion of original observations made concerning cross-fertilization and other physiological and etiological questions seems fortunately to be increasing.

### VEGETABLE ANATOMY AND PHYSIOLOGY.

Decidedly the most important work to be credited to this year, although, as before said, it in reality appeared at the end of 1880, is Darwin's admirable work on the *Power of Movement in Plants*, with regard to which a detailed account is unnecessary in this connection, inasmuch as the work is so generally and popularly known. Accepting the phenomenon of circumnutation as a fact, nothing could apparently be more satisfactory than the explanation given of the action of the different parts of the embryo in germination, and of the motions of leaves and other parts of plants. When, however, the question is asked, what is the cause of circumnutation, it will be noticed that all vegetable physi-



ologists do not agree with Darwin. The latter regards epinasty, hypnasty, geotropismus, heliotropismus as modifications of circumnutation, which is caused by an increase of the turgescence of the cells of one side of an organ. In opposition to this view is an important paper by Professor Wiesner, of Vienna, on *Das Bewegungsvermögen der Pflanzen*, who concludes that "circumnutation is not itself the cause, but a derivative; the separate forms of nutation, on the other hand, heliotropismus, geotropismus, &c., are the primary phenomena. The single force to which these forms of motion are to be referred is growth itself." Francis Darwin, in a paper in the *Botanische Zeitung* on *Circumnutation in a Unicellular Organ*, applies the method adopted in the study of the motions of flowering plants to a fungus, *Phycomyces nitens*, whose motions he thinks are in all probability to be attributed to circumnutation. The action of gravity on the longitudinal growth of plants has been studied by F. Schwarz, who comes to the conclusion that gravity has no influence on longitudinal growth when it acts in the direction of the longer axis of plant organs.

The detailed account of Pringsheim's researches on chlorophyl, with regard to which he made several communications to the Berlin Academy in the years 1879-81, and to which reference has already been made in the Report on the Progress of Botany for 1879, was published in full in Pringsheim's *Jahrbücher* for the present year, under the title *Ueber Lichtwirkung und Chlorophyllfunction in der Pflanze*. It is an elaborate paper, illustrated by 16 plates, and gives a full account of the experiments made with his special microscopic apparatus. The views of Pringsheim with regard to the chlorophyl grains acting as shields of the protoplasm against too strong light, and his view that hypochlorin is the direct product of the transformation of chlorophyl is not accepted by Pfeffer in his *Vegetable Physiology*, to which reference is made below, nor by Wiesner, who in the main agrees with Pfeffer. In a short but important paper, Dr. K. Brandt states that the chlorophyllaceous bodies found in some animals, as *Spongilla* and *Hydra*, are in reality not organs of the animals themselves, but entophytic algæ, which evolve oxygen, upon which the animals live.

In his *Physiology*, Pfeffer refers to Boehm's view with regard to the movement of water in plants, which he criticises unfavorably, and in reply to this appeared a communication by Boehm in the *Botanische Zeitung*, in which he supports his original view that the movement is brought about by suction and not by imbibition, as believed by most physiologists of the present day, nor, as was formerly supposed, by capillarity. In the Proceedings of the Berlin Academy is a paper by Schwendener on *Climbing Plants*, in which he treats of the effect of geotropism, the grasping of the support in consequence of the formation of spirals by nutation, &c. The *Jenaische Zeitschrift* contains an article by Stahl on *So-called Compass-plants*. In addition to *Silphium laciniatum*, the well-known compass-plant, he found that *Lactuca scariola*, and to some

extent *Lactuca saligna*, *Aplopappus rubiginosus*, *Ohondrilla juncea*, and probably other plants, also place their leaves in a meridional position. The cause of this he attributes to the unusually great sensitiveness of the leaves of the species named to the action of light.

The subject of plant respiration has been studied by Borodin, who maintains more strongly than ever his opinion that the energy of the respiration in leafy shoots under constant external conditions is a function of the carbohydrous material which is present in the plant. Dr. Th. W. Engelmann, in a paper in the *Botanische Zeitung*, describes a new method for the investigation of the exhalation of oxygen by plants and animals. He makes use of the bacteria, which commonly produce putrefaction. Their motions cease when the supply of oxygen is shut off, and revive when it is renewed, and by watching their motions one can tell whether oxygen is being evolved by plants or animals near them.

In the *Botanische Zeitung* for 1880, Schimper gave an account of the origin of starch-grains, and this was followed in 1881 by a paper on *Growth of Starch-grains*, in which the author expresses the view that starch-grains are crystalloid substances, and he opposes strongly the view of Naegeli that they increase by intussusception. In reply Naegeli published an article in the same journal, upholding his original view against Schimper. Arthur Meyer, in an article which also appeared in the *Botanische Zeitung*, on the *Structure of Starch-grains*, takes the ground that Naegeli's theory of intussusception has not been disproved by Schimper's observations, although he agrees that Schimper's hypothesis, that starch-grains are sphærocrystalloids of a carbohydrate, affords the simplest explanation of the formation of the layers.

The crystalloids found in marine algæ are described in Pringsheim's *Jahrbücher* by Klein. The paper is followed by one on the *Crystalloids in the Nuclei of Pinguicula and Utricularia*. Zacharias has two papers in the *Botanische Zeitung*; one on the *Chemical Constitution of the Nucleus*, and the other on *Spermatozoids*. The main part of the nucleus of vegetable cells consists of nuclein, which is also found in what Strasburger calls the nuclear plate formed during cell division. In the second paper Zacharias states that as far as their chemical composition is concerned the spiral bands of the spermatozoids of plants resemble the bodies of the spermatozoa of animals, while the cilia resemble the tails of the latter. Furthermore the spiral bands, as is shown by their containing nuclein, originate in the nuclei of the mother cells, while the cilia arise from the cell-plasma. The *Untersuchungen* of the Göttingen laboratory contain papers by Reinke and Rodewald entitled *Studien über Protoplasma*. The first gives detailed analyses of the protoplasm of *Æthaliu septicum*. The other papers relate more particularly to the assimilation and metastasis occurring in cells. According to Prof. F. Schmitz, in an article on *Formation and Growth of the Cell-membranes of Plants*, the cell walls are formed by centripetal apposition, and not by

intussusception, and he gives as an illustration the pollen grains of *Cobæa scandens*, where the spiny outer wall is formed earlier than the inner wall. Karl Richter shows that the cell walls of fungi are formed of cellulose proper, rather than of what is called fungus cellulose, since on treating with potash they give the reactions of cellulose. Vesque, in the *Annales des Sciences*, gives an account of some peculiar cellulose formations.

An important paper by Schwendener on the *Structure and Mechanism of Stomata* was published in the Proceedings of the Berlin Academy, in which the hinge-like action of the closing cells dependent on the position of the thickenings of their walls in certain positions was explained. Pringsheim's *Jahrbücher* contains two elaborately illustrated anatomical papers; one by Ambronn on the *Development and Mechanical Properties of Collenchyma*, and one by Haberlandt on the *Comparative Anatomy of the Assimilating Portion of Plants*; also a paper by Westermaier on the *Intensity of Growth of the Scheitel-cell and its Earliest Divisions*, to which there is a reply by Goebel in the *Botanische Zeitung*. The *Annales des Sciences* for the present year is almost wholly devoted to articles relating to vegetable anatomy, several of which are copiously illustrated, the principal papers being those of Olivier on *L'Appareil tégumentaire des racines*, of Gérard on *le Passage de la racine à la tige*, and of Guignard on *Embryogénie végétale comparée*.

The *Journal of Botany* contains a paper, by Vines, on the *History of the Scorpoid Cyme*, and by Dickson on the *Morphology of the Pitcher of Cephalotus follicularis*, in which he differs from Hooker in regarding the pitchers as formed from the upper part of the leaves rather than as special structures developed on the prolonged midribs. There is also a paper, by Eichler, on the pitchers of *Cephalotus follicularis* in the *Jahrbuch* of the Royal Botanic Garden of Berlin.

The vegetative organs of *Monotropa hypopitys* have been studied by Kamienski, who found no haustoria, and concluded that the plant is not a parasite, but a saprophyte, and he states that a mycelium is always found in the ground about the *Monotropa* roots, and that the nourishment of the roots may, perhaps, depend on the action of the mycelium on plants around. In a paper on the *Weibliche Blüten der Coniferen*, Eichler states his belief that the ovule of Coniferæ, or, as it may be called, macrosporangium, like the corresponding organ in the higher cryptogams, is of the nature of an emergence, and may arise either from a leaf or an axis.

An important work, by Hermann Mueller, on the relations of plants to insects, is *Alpenblumen, ihre Befruchtung durch Insekten und ihre Anpassungen an dieselben*. The work is divided into four parts, of which the second and third are especially valuable to botanists, as they contain detailed, and in many cases illustrated, accounts of the arrangements for cross-fertilization in a large number of species. *Fertilisation in Rhexia virginica* is described and figured in the *Torrey Bulletin*, by

W. H. Leggett. William Trelease has, in the same journal, two papers on *Fertilization of Scrophularia* and *Perforation of Flowers*. Trelease has also two papers in the American Naturalist on *Fertilization of Calamintha Nepeta* and on the *Fertilization of Salvia splendens by Birds*. Dr. W. P. Wilson, in the Tübingen Laboratory, has made a study of the *Cause of the Excretion of Water on the Surface of Nectaries*, and finds that it is caused by osmosis, and not by pressure from within the cells, as is shown by the experiment of thoroughly drying the surface of nectaries with filter paper, when the flow of nectar ceases until the surface is again touched with some substance which favors an osmotic flow. The foliar *Nectar Glands of Populus* are described and figured by Trelease, in the Botanical Gazette for November, where he makes some suggestive remarks on the origin of such glands and their relative frequency in living and fossil species of poplar.

Some important text-books relating to vegetable anatomy and physiology have appeared during the year. The most important is the *Pflanzenphysiologie* of Professor Pfeffer, of Tübingen, of which two parts have appeared, covering respectively 383 and 484 pages, and illustrated by a small number of wood-cuts. The first part relates to the subject of *Stoffwechsel* and the second to *Kraftwechsel*. The *Elemente der Anatomie und Physiologie der Pflanzen* of Professor Wiesner, of Vienna, is a volume of 272 pages, with numerous good wood-cuts, and embodies the substance of his class lectures on these subjects, and other botanical subjects will be treated in subsequent volumes. Strasburger's *Zellbildung und Zelltheilung* has reached a third edition, in which is embodied the latest results of the very numerous investigations made with regard to the cell structure in the last few years. The German translation by Dr. Carl Müller from the Danish of *Botanische Mikrochemie*, by Dr. V. A. Poulsen, places that convenient little book within the reach of botanical teachers.

#### BACTERIA.

A very large number of papers has appeared on bacteria and their relation to disease, most of which have treated the subject from a medical point of view, and only an unusually small number has been devoted to the botanical aspects of the subject. The two largest and most complete publications are *Aetiologie der Infektionskrankheiten*, with special reference to the fungus theory, an octavo volume of over four hundred pages and several charts, comprising 15 papers read before the Medical Society of Munich in 1880. The other work, *Mittheilungen aus dem kaiserlichen Gesundheitsamte*, published in Berlin under the direction of Dr. Struch, is a quarto volume of 400 pages, with 14 lithographic plates, and contains 14 articles relating to the action of pathogenic organisms, means of disinfection, &c. As a rule, the physicians of Munich are adherents of Nägeli, who regards the different so-called pathogenic forms not as distinct species, but rather as modifications of the same species, or of a few distinct species which produce different

changes according to the different conditions under which they are placed, and which may, by natural or artificial means, be transformed one into another. The Berlin school, on the other hand, deny that the different organisms are modifications of a few common forms brought about by changes in external conditions, but maintain that they are permanent forms capable of perpetuating themselves indefinitely without undergoing any change, either in their morphological structure or their pathological action. There is no way at present of reconciling these two widely different views, for each side accuses the other of lack of care in conducting experiments and inoculations. In the Munich volume Bollinger gives a historical account of the diseases caused by fungi in lower and higher animals; Bezold, a paper on *Otomycosis*, in which he expresses the view that in the case of *Aspergillus* and similar fungi the spores make their way into the ear, and produce an inflammation, although in some of the cases recorded a growth of the fungus was not noticed until oil had been applied to the ear. The ætiology of diphtheria is discussed in two papers by Oertel and Ranke, followed by a discussion, in which several medical men took part. The principal point at issue was whether there exists a disease with membranous exudation in the throat which is not of a diphtheritic nature. In the present connection it is only necessary to state that it seemed to be admitted by both sides that the bacterial forms found are the same in all cases, and not to be distinguished from those found also in healthy persons. In the same volume are two articles by Buchner on the *Action of Bacteria in Living Bodies* and on the *Conditions of Diffusion of Fungi in the Air*. In the first-named paper he refers to the experiments previously made by himself on the interchangeability of *Bacillus anthracis* and *B. subtilis*, and states that the fatal result of pathogenic organisms is not so much owing to their poisonous action on the whole system as on special organs or parts of the body. In the second paper he remarks that when in fluids bacteria are not readily transported through the air, but when the substance in which they are contained is dry it is likely to become reduced to dust or small fragments, and in this form the bacteria are taken up by the air and absorbed by animals. In a paper on the *Ætiology of Abdominal Typhus*, Port states that the disease is caused by emanations from the soil, and is propagated by particles in the air, and not by drinking water.

In the Berlin Mittheilungen, Koch has a paper on the mode of studying pathogenic organisms. His method is to make use of solid or semi-solid substances rather than fluids in his cultures, as in the latter the different kinds of bacteria which make their appearance are mixed together in utter confusion, while when cultivated on substances like potato or carrot, for instance, the different forms grow in masses in distinct spots which can be easily seen, and the different forms obtained nearly or quite pure. His favorite substance for pure cultures is gelatine combined with various nutritive fluids, depending on the partic-

ular species to be studied. The article is illustrated with numerous micro-photographs. In his paper on the *Ætiology of Splenic Fever*, Koch attacks the views of Pasteur and other French writers, as well as those of Buchner, with regard to the specific identity of *Bacillus anthracis* and *B. subtilis*, and denies that earth-worms have the influence in spreading the disease which was attributed to them by Pasteur. He distinguishes between splenic fever and malignant œdema, which he thinks have been confounded by Pasteur, and maintains that the Bacilli which produce the two diseases are distinct, and he even hints that there are probably other diseases of a similar nature which will also be shown to be produced by distinct forms of Bacillus. In his paper on *Progressive Virulence and Acquired Adaptability in Septicæmia*, Gaffky affirms the constancy of pathogenic organisms and controverts the views of Gramitz in Virchow's Archiv, on the *Theory of protective inoculation*, who there states that not only bacterial forms but even harmless molds may, by changing the temperature and in other ways, be converted into dangerous organisms. With the exception of a paper by Löffler, on the *Immunity Question*, most of the remaining articles in the Mittheilungen relate to means of disinfection, which is best accomplished by the use of steam, which destroys the spores of bacteria more quickly than hot water, sulphurous acid, or other disinfectants. In the Medizinische Wochenschrift is a short paper by Huber, *Experimentelle Studien über Milzbrand*, in which, among other facts, he states that the Bacilli of splenic fever do not pass through the placenta of the mother to the fœtus. In the Zeitschrift für klinische Medizin is a paper by Nothnagel on the lower vegetable organisms found in the intestinal discharges of man, in which he mentions the occurrence of a form resembling *Clostridium butyricum* Prazmowski, which is turned blue by iodine. Dr. G. M. Sternberg, at the meeting of the Am. Ass. Adv. Sci., at Cincinnati, read a paper on *Bacterial Organisms found on exposed Mucous Surfaces and in the Alimentary Canal of Healthy Individuals*, giving the mode of examination and the results of observations made at the Johns Hopkins University.

The work done by French writers on bacteria has related principally to the means of diminishing the virulence of the poison in different diseases and to inoculation in splenic fever and chicken cholera. At the International Medical Congress, in London, Pasteur delivered an address in which he summed up the result of his researches concerning inoculation in chicken cholera and splenic fever. The Comptes Rendus contain numerous original communications by Pasteur, Chaveau, Chamberland, Raux, and others. In a communication on the duration of life of germs, Pasteur, in connection with Chamberland and Raux, found that guinea pigs died of splenic fever when inoculated with particles of soil taken from fields where infected animals had been buried twelve years previous. Furthermore, sheep which were allowed to resort to the same fields, on which, however, as no grass was growing, they

could not feed, also died of splenic fever. The same observers in a paper on the attenuation of virus and its return to virulence give the results of their researches on the means of reducing the virulence of the microbes, more especially those of chicken cholera and splenic fever. The microbe of the first-named disease does not produce spores when made to grow in a decoction of chicken flesh exposed to the air, and it was possible by successive cultures to produce a microbe which became gradually less and less virulent, and at length quite inert when injected into fowls. The nearly inert solutions when injected into fowls enable them to resist violent attacks of chicken cholera when exposed to the disease. The bacilli of splenic fever, however, when cultivated in fluids exposed to the air generally produce spores which retain for an indefinite period the virulence of the disease. When, however, the temperature is kept as low as 16° C. or above 40° C. the filaments of the bacillus grow without producing spores, and by successive cultures under these conditions Pasteur obtained an inert fluid for inoculation in splenic fever. In a later paper in the *Comptes Rendus* the results of inoculations in splenic fever made at Pouilly le Fort, near Melun, are given, and the results show that the animals inoculated did not contract the fever when exposed, while non-inoculated animals did. Chaveau, also in *Comptes Rendus*, gives his results with regard to inoculation in splenic fever, which was followed by exemption from the disease; but his injecting fluid he obtains in a different way from Pasteur, making use of fluids in which only a minute number of bacilli are found, and he believes that the virulence depends on the amount of bacillus present.

In *Nuovi studi sulla natura della malaria* Cuboni and Marchiasava confirm the views of Tommasi-Crudelli, that the disease is caused by a Bacillus, and state that during the fever only free spores are found in the blood, while during the chill there is a large mass of Bacilli to be seen. In the *Proc. Phil. Acad.* is a preliminary notice by Dr. H. C. Wood, and in the *Bulletin of the National Board of Health*, No. 17, is a detailed account by Drs. Wood and Formad on the cause of diphtheria. They find microcci in the membrane of diphtheria which are not to be distinguished from those found in pseudo-membranous trachitis, arising from various causes, but on the whole are inclined to admit the agency of the microcci, at least to a certain extent, in causing diphtheria. In a paper by Dr. Sternberg on a *Fatal Form of Septicæmia*, in the rabbit, produced by the subcutaneous injection of human saliva, he states that he has demonstrated by repeated experiments that his saliva in doses of 1.25 c. c. to 1.75 c. c. injected into the subcutaneous tissue of a rabbit infallibly produces death, which he thinks is owing to the presence of a Micrococcus which closely resembles, if it is not identical with, *Micrococcus septicus* Cohn. The Report of the Department of Agriculture for 1880 contains several elaborate illustrated papers on diseases of domestic animals, with accounts and figures of the organ-

isms found in the different organs, viz: *Swine Plague and Fowl Cholera*, by Dr. D. E. Salmon; on *Swine Plague*, by Dr. James Law, and a second paper on the same subject by Dr. H. J. Detmers; on *Contagious Pleuro-Pneumonia*, by Dr. O. P. Lyman; and on *Texas Cattle Fever*, by Dr. Detmers. The existence in man of a disease similar to that produced in cattle by the fungus known as *Actinomyces bovis* has recently been made known in a paper by Ponfick, entitled *Die Aktinomykose des Menschen*, and by Johnes, in a paper bearing a similar title. The disease usually attacks at first the region of the mouth with secondary internal manifestations. The fungus which occurs in man closely resembles that found in cattle, but its botanical relation to other fungi is very obscure, and cultures artificially made failed to throw any light on the subject.

Under the present heading should be mentioned an account, by Dr. Swann M. Burnett, of a fungus *Otomyces purpureus* found in the human ear, published in the Archives of Otology; and an account, by Ercolani, of a disease of horses' hoofs, caused by a fungus *Achorion keratophagus* described and figured in the Revue Mycologique.

#### DISEASES OF PLANTS.

Very little has been published in 1881 relating directly to diseases of plants, although frequent reference has been made to such diseases in papers treating of fungi and bacteria. The handbook, by Frank, *Die Krankheiten der Pflanzen*, published in 1880-'81, a semi-popular work, gives a thorough and intelligible account of the diseases of vegetable origin, with a shorter account of some of insect origin. H. Marshall Ward, who was sent by the British Government to Ceylon to study the coffee disease, *Hemileia vastatrix*, has succeeded in finding nearly the complete development of that fungus, which he classes with the *Uredineæ* as he has found teleutospores which belong to that order. The agricultural and smaller botanical journals are filled with descriptions, generally of a popular character, of the diseases of the vine, especially of *Peronospora viticola*. Investigation with regard to the spreading and means of checking the *Peronospora* have been conducted by Prillieux in France, and Garovaglio in Italy. The former reports the spreading of the disease to Algiers, where it occurs with great violence early in the summer, attacking not only the leaves but the grapes themselves. As far as the injury done to the French vineyards is concerned, Prillieux does not think that the harm is very great except in unusually wet years, although he says that in the region of Bordeaux the *Peronospora* makes its appearance sometimes as early as the last of May or first of June. He does not agree with Garovaglio as to the value of the application of lime as a preventive. In a paper read at the Italian Cryptogamic Society, Passerini described four species of fungi which attack tobacco, *Phyllosticta tabaci*, *Ascochyta nicotinae*, *Epicoccum purpurascens*, and *Macrosporium commune*. In a paper called *Mal nero della*



vite, Cugini figures different forms of *Phoma* and *Sphaeropsis* which occur on the vine. Prillieux has a note in the Comptes Rendus on the root-rot of the vine caused by *Rosleria hypogæa*, and Le Monnier gives the result of his observations on the disease in the Bulletin of the Natural History Society of Nancy. Prillieux, who examined the disease of hyacinths in France, which is supposed to be the same as what is called in Germany "ringel krantheit," considers that the disease is caused by insects and not by molds, as was believed by Sorauer. In the American Naturalist are papers by Prof. T. J. Burrill and W. K. Higley. The former, in his article on *Bacteria as a Cause of Disease in Plants*, gives an account of his studies of the pear blight which, he thinks, is caused by a form of bacterium and which can be transferred by inoculation to healthy trees. The "yellows" of peaches is caused by a similar bacterium, as are also diseases of the Lombardy poplar and the aspen. The paper of Mr. Higley is entitled the *Microscopic and General Characters of the Peach Tree affected with the Yellows*, which he attributes not to bacteria, but to some higher form of fungus of which he found the mycelium.

#### THALLOPHYTES.

The paper of De Bary, *Zur Systematik der Thallophyten*, published in the Botanische Zeitung for January, makes a change in the disposition of the members of this difficult group of cryptogams, and his views on the subject are again expressed later in the year in his *Untersuchungen über die Peronosporeen, &c.* The four principal divisions, *Carposporeæ*, *Oogamæ*, *Isogamæ*, and *Agamæ*, correspond in general to the four divisions of Sachs, but the arrangement of the orders under them is different, and, to illustrate his views of the connection of the order, De Bary gives a somewhat complicated table in which, under the four main divisions mentioned above, are several vertical columns in which the orders are arranged so as to show their relation to one another and the higher cryptogams. The chlorophyllaceous algæ form the base which passes through the *Oedogoniæ* and *Coleochæte* to the *Bryophyta* and *Pteridophyta*, while the *Florideæ* and *Fungi* on one hand, and the *Phæophyceæ* on the other, form aberrant groups. The Botanische Zeitung for August contains another classification of Thallophytes by Gobi. He proposes to substitute the name *Glæophytæ* for *Thallophytes*, owing to the gelatinous nature of the cells in this group, and gives a table in which De Bary's four main divisions are represented as segments of concentric circles, and the orders, taken somewhat comprehensively, to be sure, are represented by radial lines. In the Giornale Botanico, Caruel also proposes a new system of the vegetable kingdom in which the arrangement of the *Thallophytes* is new. In this connection may be mentioned the work of Saprota and Marion, *Évolution des cryptogames*, which, although properly coming under the department of paleontology, contains a summary of what is known of the development of living *Thallophytes*.

*Algæ*.—Number four of the monographs, to illustrate the flora and

fauna of the Bay of Naples, appeared in 1881, and includes the genus *Corallina*, by Graf Solms-Laubach. It is a small folio of 64 pages, with 3 lithographic plates. It begins with an enumeration of the *Corallinæ* of Naples, which is followed by an account of the development of the fruit in the genus *Corallina*, and remarks on *Amphiroa*, *Melobesia*, *Lithophyllum*, and *Lithothamnion*. In the proceedings of the Zoological Station at Naples is a paper, by Berthold, on the *Sexual Reproduction of the Phæosporeæ Proper*. In *Ectocarpus siliculosus* he found that some of the zoospores came to rest earlier than others. These were the females, around which the males collected in considerable numbers, until one of the latter became fused with the female, which was then surrounded by a cell-wall, and germinated. In the *Botanische Zeitung* is a paper by Klebs, *Beiträge zur Kenntniss niederer Algenformen*, in which a number of new endophytic algæ are described, including three new genera, *Endosphæra*, *Phyllobium*, and *Scotinosphæra*. In *Hedwigia*, Wollny gives an account of the algæ of Helgoland. Of papers on Desmids may be mentioned Nordstedt's *De Algis nonnullis, præcipue Desmideis, inter Utricularias Musei Lugduno-Batavi*, in which he describes species from Senegal, Venezuela, the Cape of Good Hope and Java, and Archer's *New Zealand Desmids* in *Grevillea*. The *Encyklopädie der Naturwissenschaften* contains a general account of algæ by Falkenberg, entitled *Die Algen im weitesten Sinne*, a paper of 143 pages, with numerous woodcuts.

Of publications relating to algæ of the United States should be mentioned Farlow's *Marine Algæ of New England and Adjacent Coast*, which forms a part of the Report of United States Fish Commission for 1879, comprising an account of all the marine species known to occur in that region, with the exception of the diatoms. The paper is accompanied by plates showing the microscopic structure of the different genera. The *Sea Mosses*, by Rev. A. B. Hervey, gives popular descriptions of the more striking sea-weeds of the United States, with colored illustrations, besides an introduction on the general structure of algæ. The *Torrey Bulletin* contains two papers by Wolle on *American Fresh-Water Algæ*, with a plate of new American Desmids, and a note on *Laminariæ* by Farlow. Mr. C. M. Vorce gives, in the Proceedings of the American Society of Microscopists, two plates with notes representing the forms of microscopic vegetable and animal life observed in the water of Lake Erie. The fourth fasciculus of *Algæ Am. Bor.*, by Farlow, Anderson, and Eaton, was issued in June, 1881, and contains principally species of *Florideæ*.

The diatoms collected on oysters at Ningpo and Nimrod Sound, China, is the subject of an illustrated paper by P. Petit in the memoirs of the Cherbourg society. Cleve gives descriptions and plates of diatoms from Honolulu, the Galapagos Islands, Port Jackson, and the Mediterranean in a paper entitled *On some new and little known Diatoms* in the proceedings of the Swedish Royal Academy. The genus *Grammatophora*, in connection with plates 53 and 53 B of Van Heurck's *Synopsis of*

Belgian Diatoms, is the subject of a paper by Grunow in the *Botanisches Centralblatt*. The subject of *Fineness of Striation as a Specific Character of Diatoms* is discussed in the *Am. Monthly Microsc. Journal* by Prof. H. L. Smith, in which he takes strong ground against the views of Castracane, and regrets that so many new species are founded on the variable distinctions of striation. In the same journal, Dr. G. M. Sternberg states that he is able to confirm the views of Wallich, that the motions of diatoms are produced by delicate filaments projecting from the valves. Of Van Heurck's *Synopsis des Diatomées de Belgique*, part 3, plates 31-53, including the *Pseudo-Rhaphideæ*, appeared during the year, and parts 17-18 of Schmidt's *Atlas der Diatomaceenkunde*. The first part of Habirshaw's *Catalogue of the Diatomaceæ* also appeared this year.

*Lichens*.—The first part of Minks' *Symbolæ licheno-mycologicæ*, which the author styles a contribution to the knowledge of the boundaries between lichens and fungi, appeared towards the end of 1881, and a continuation is promised. He gives a catalogue of a large number of recognized fungi, many of which are common species, in which he declares that he has found microgonidia, and hence concludes that they are not fungi, but lichens. In the introduction he advances some decidedly novel views on the formation of asci and spores. In the *Giornale Botanico*, Mattirollo gives the results of his study of the genus *Cora*, of which he recognizes two species, making a new genus, *Rhipidonema* of *Cora ligulata*. The genus *Cora*, which has by some been considered to belong to fungi and by others to lichens, has fruit resembling the *Auricularini*, but has also gonidia, and for this reason Mattirollo creates the new division of lichens, which he calls *Hymenolichenes* to include the two genera above named.

The descriptive notices of lichens which appeared during the year were principally continuations of periodical communications. In the *Torrey Bulletin*, Willey calls attention to a new North American lichen, *Omphalodium Hottentottum* var. *Arizonicum* Tuck, and he has also a note on *Similarity between the Lichen Flora of Africa and South America*. *Flora* contains a continuation of Nylander's *Addenda nova ad Lichenographiam Europeanam* and Mueller's *Lichenologische Beiträge*, the last of which includes species from nearly all parts of the world. Mueller also describes a number of Swiss lichens, especially from the Valais, in the *Bull. Soc. Murithienne du Valais*. The *Lichenologische Fragmente* of Arnold have been continued in several numbers in *Flora*. Contributions to British lichens have been made by Crombie in *Grevillea* in two articles, *Observations on Parmelia olivacea and its British Allies*, and *New British Lichens*. In France the third fascicle of Roumeguère's *Lichenes Gallici exsiccati* has appeared, and in Italy there has been published *Anacrise dei licheni della Valesia* by Baglietto and Carestia, and two papers by Jatta in the *Giornale Botanico*, on some lichens in the herbarium of De Notaris. In *Flora*, Fries has a note on the lichens of Ehrhart. Contributions to the lichen flora of Lapland have been made by Wainio.

*Fungi*.—Two important papers by De Bary relating to *Peronosporæ* are *Untersuchungen über die Peronosporeen und Saprolegnieen*, and *Zur Kenntniss der Peronosporeen*. The first-named paper forms the fourth series of De Bary and Woronin's *Beiträge zur Morphologie und Physiologie der Pilze*, and includes 145 quarto pages, with 6 lithographic plates. It is devoted especially to the consideration of the reproductive process in the two orders named above as illustrated by the genera *Pythium*, *Phytophthora*, *Saprolegnia*, and *Achlya*. In the case of the *Saprolegnieæ*, De Bary thinks that in forms where oogonia are found without male pollinodia they must be considered as representing a distinct apogamous species, and not as temporary variations of bisexual species. At the end is a chapter on the basis of a natural classification of fungi. The second paper of De Bary's, which appeared in the *Botanische Zeitung*, takes up more in detail than in the previously-named paper the development of certain species of *Pythium* and *Phytophthora*, which, according to De Bary, have a much wider diffusion and inhabit a greater variety of host plants than has been supposed. The fourth part of Brefeld's *Botanische Untersuchungen über Schimmelpilze* includes 11 articles on different mycological subjects, in the last of which, the *Comparative Morphology of Fungi*, he gives his views on classification, and adopts the view which is beginning to prevail in some quarters that the larger and, as they have been supposed, more highly developed forms of fungi are in reality degenerate non-sexual forms descended from sexual ancestors. The other papers relate to the mode of making microscopic cultures the development of different species of *Mucorini*, *Ascomycetes*, &c. In his *Beitrag zur Biologie der Mucorineen*, Wortmann shows that the bending of the sporangial stalks and mycelium is not dependent on a force called somatotropismus by Van Tieghem, but on the varying amounts of moisture in the substratum. The *Relationship of Aecidium Berberidis to Puccinia Graminis* is discussed by C. B. Plowright, in *Grevillea*, of December, 1881, where he gives the results of a number of cultures made with the object of determining whether there is a genetic connection between the forms mentioned, and he considers that his experiments do not show in a conclusive way that there is any such connection. In the contributions from the Carlsberg Laboratory, Copenhagen, Hansen has a paper on the *Physiologie et morphologie des ferments alcooliques*, the principal species studied being *Saccharomyces apiculatus*. The fungus abounds on small fruits, as cherries, gooseberries, &c., in summer, and falls or is washed to the ground in autumn, where it remains through the winter enduring considerable cold without injury. It produces alcoholic fermentation, but only to a small extent.

Descriptive works on fungi have been very numerous in 1881. Relating to this country we may mention, in the *Torrey Bulletin*, papers by Ellis on *New Species of North American Fungi*, principally from New Jersey, and *New Ascomycetous Fungi*; Ellis and Harkness on *New Species of American Fungi*; Peck on *Two New Species of Fungi*, with a plate of

*Ascomycetella quercina*; and Gerard on *Some Fungi from New Mexico*. In the Botanical Gazette are *New Species of Fungi*, by Peck, and *New Species of Maryland Fungi*, by Miss Banning; and in Grevillea *Californian Fungi and Fungi on Eucalyptus*, by Cooke and Harkness; and *New Jersey Fungi*, by Cooke and Ellis. The *Gymnosporangia of the United States*, by Farlow, which appeared as one of the papers in the volume of Anniversary Memoirs of the Boston Natural History Society, gives descriptions and figures of the American species, and observations on the genetic connection between the genera *Gymnosporangium* and *Rozestelia*, the writer not finding that Oersted's view as to the connection of certain species was confirmed by observations in this country. Supplementary to this paper is a *Note on Gymnosporangia* in the Torrey Bulletin. The sixth and seventh centuries of Ellis's North American Fungi appeared this year.

Species of fungi new to Great Britain were published in Grevillea by Cooke, Plowright, and Philips, and by Berkeley and Broome, in the Annals and Mag. Nat. Hist. A new illustrated work by Cooke, called *Illustrations of British Fungi*, to include plates of *Hymenomyces*, has appeared, and will be continued in parts. Oudemans has issued a *Révision des champignons trouvés . . . dans les Pays-Bas*. Hedwigia contains a number of mycological papers: *Einige neue Pyrenomyceten*, in which Niessl describes some species sent to him for examination by Rabenhorst shortly before his death, and notes on *Microthelia* and *Didymosphæria* by the same author, who does not agree with Rehm in uniting the genera; and three papers by Winter, *Fungi Helvetici Novi*, *Peziza Sauterianæ*, and notes on *Discomycetes*. A list of works relating to Italian Fungi is given in Michelia by Saccardo and Penzig. The Atti della Soc. Critt. Ital. contains an addition to the Mycologia Veneta, by Spegazzini, and the Giornale Botanico, a continuation of the *Funghi Parmensi*, by Passerini. *Fungi Tridentini* contains colored plates by J. Bresadola. Fungi of Finland have been described by Karsten in Hedwigia, and the same writer gives an enumeration of Finnish *Polyporei*, *Auricularini*, *Hydnei*, and *Clavariæ* in the Revue Mycologique, where he forms a considerable number of genera out of older ones. Gillet has issued a supplement to his *Champignons de la France*, containing plates of *Hymenomyces*. The Revue Mycologique contains a number of papers on French fungi, among them continuations of *Fungi Gallici*, by Roumeguère; an account of species collected in the Vosges by Quelet and others; and of species from the department of the Saone and Loire, by Lucand and Gillot. The Revue also contains an account of some Algerian species by Saccardo, under the title *Fungi Algerienses Trabutiani*. The new edition of Rabenhorst's *Kryptogamen Flora*, of which the fungi are written by Winter, is an important work, of which several parts have been issued, including *Schizomyces*, *Saccharomyces*, *Ustilagineæ* *Uredineæ*, and *Tremellini*. Fungi from Australia have been described in the Journal of the Linnean Society by Berkeley, and in

*Grevillea* by Cooke. Kalchbrenner has continued his account of Cape fungi, *Fungi Macowaniani*, in *Grevillea*, and in the Memoirs of the Hungarian Academy he has published an illustrated monograph, *Phalloidei novi vel minus cogniti*. The fungi of the late Mlle. Libert form the subject of two papers; one by Cooke and Philips in *Grevillea*, which includes *Discomycetes*, and the other by Roumeguère and Saccardo in the *Revue Mycologique*, including, principally, *Pyrenomycetes* and *Fungi imperfecti*. Several decades of dried fungi, from Buenos Ayres and Brazil, have been issued by Spegazzini, under the name of *Hongas-sud-americanos*. The *Mycotheca universalis* and other European series of dried fungi has been continued in several centuries.

*Characeæ*.—In the Memoirs of the University of Lund, Nordstedt describes the *Characeæ* of New Zealand collected by Dr. S. Berggren, who found double the number of species previously known to exist in that region. J. Mueller, in the Bull. Soc. Bot. of Geneva, describes the *Characeæ* growing near that city. The occurrence of *Chara obtusa* Desv. in Britain is recorded by Henry and James Groves, who also have *Notes on British Characeæ* in the Journal of Botany. A fasciculus of American *Characeæ* has been issued by Dr. T. F. Allen, of New York.

#### ARCHEGONIATA.

*Muscineæ*.—In this department of botany there have appeared a number of descriptive works, but very few relating to development. Of the latter the most important is Leitgeb's *Untersuchungen über die Lebermoose*, which is continued in a fourth volume treating of the *Marchantiaceæ*, with general remarks on *Hepaticæ*, illustrated with eleven plates. He gives his observations especially on the organs of reproduction and discusses the arrangement of the genera, which he places in three tribes: *Ricciæ*, *Corsiniæ*, *Marchantieæ*. He defines four types of sporogonium in liverworts, but recognizes only three in mosses. Leitgeb also has a paper on the position of the fruit-sack in some of the *Jungermannieæ* in the Proceedings of the Vienna Academy. Klein records the occurrence of buds on the inflorescence stalks of *Marchantia*. In Flora, Jack gives descriptions of the European species of *Radula*. The *Hepaticæ* collected in Tasmania and New Zealand by Beccari have been described by Hampe and Geheeb in the *Revue Bryologique*. In the way of exsiccatae we would notice the appearance of the eleventh and twelfth decades of Massalongo's *Hepaticæ Italice Venetæ*.

On the subject of mosses we have to notice in Great Britain the appearance of a reprint of the *London Catalogue of British Mosses and Hepaticæ* under the direction of the Botanical Record Club, also the fourth part of Braithwaite's *British Moss Flora*, comprising the *Fissidentaceæ*. In Germany we should mention the work of Warnstorf, *Die Europäischen Torfmoose*, with critical descriptions of species, and the *Sphagnotheca Europæa* of the same writer, which is a collection of 50 dried specimens of *Sphagna*. In answer to Warnstorf, there was a reply by Lim-

pricht in relation to the determination of certain species in the Bot. Centralblatt, to which in return Warnstorf replied at some length. Limpricht has described some mosses new to Silesia and new species of the genus *Sarcoscyphus*. *Die Moose Deutschlands* is the title of a work by P. Sydow, intended as an introduction to the study and determination of German mosses. Mosses from the north of Europe have been described by Lindberg, from the Pyrenees by Renauld, from Brazil by Hampe, and from Reunion and Madagascar by Mueller and Geheeb in *Reliquiæ Rutenbergianæ*. Four new genera from India, Africa, and Java have been described by Mueller in the Bot. Centralblatt.

*Higher Cryptogams and Ferns.*—In the second part of his *Beiträge zur vergleichenden Entwicklungsgeschichte der Sporangien*, published in the Botanische Zeitung of this year, Goebel shows that an archespor exists in several vascular cryptogams where its existence had not been suspected. After some observations on the *Marattiaceæ*, *Ophioglossum*, and *Selaginella*, he compares the development of the pollen-sacks of *Coniferæ* with their sporangia. In conclusion he proposes a new classification of the higher cryptogams, including fossil as well as living representatives. Prantl in the Botanische Zeitung gives the results of his experiments on the nutrition of the fern prothalli and the distribution of the sexual organs. The same writer has a preliminary communication on the *Morphology, Anatomy, and classification* of *Schizaceæ* in Engler's Jahrb. In Eichler's Jahrb. is a review of the genus *Adiantum* by Max Kuhn. Additions to the fern flora of the West Indies have been made by Jenman. A number of papers on American ferns have appeared in the Torrey Bulletin and Botanical Gazette. In the first-named journal are Nos. 9, 10, and 11 of Eaton's *New or Little-known Ferns of the United States*, containing critical notes on species principally from the West, and from Florida. A new American fern, *Cheilanthes Parishii*, is described and figured by G. E. Davenport, who also has a paper on *Vernation in Botrychia*, and one on *Onoclea sensibilis* var. *obtusilobata*. There is also a note by L. M. Underwood on the last-named species. Mr. John Robinson records the occurrence of *Botrychium simplex* near Salem, Mass. In the Botanical Gazette are accounts of New Mexican ferns by H. H. Rusby, of Arkansas ferns by F. L. Harvey, and of Florida ferns by Miss M. C. Reynolds. Sets of Trinidad ferns, collected by Fendler and determined by Eaton, have been offered for sale; also, the second series of A. H. Curtiss's *Southern Ferns*.

The development of *Azolla* has been made out for the first time by Berggren, who published the results of his investigations, with illustrations, in the Proceedings of the University of Lund. The species studied by him was *Azolla Caroliniana*, and the development, which was nearly completely ascertained, although the act of fertilization was not directly seen, was found to resemble closely that of *Salvinia*. A biological peculiarity of *Azolla Caroliniana* was described by Westermaier and Ambronn, who found that the root-cap remains but a short time, is then

thrown off, and the naked apex then retains its activity. An account of the development of the embryo of *Isoetes lacustris* is given by Kienitz-Gerloff in the *Botanische Zeitung*.

## PHÆNOGAMS.

But a brief notice can be given of the numerous descriptive works on phænogams which have appeared during the year. Relating to this country we have to notice a *List of State and Local Floras* of the United States, by Gerard and Britton, in the *Torrey Bulletin*; a *List of New Jersey Plants*, including also cryptogams, by N. L. Britton; a *List of Michigan Plants*, by Irwin F. Smith, and a *Catalogue of the Phænogamous and Vascular Cryptogamous Plants of Indiana*, by the editors of the *Botanical Gazette* and Professor Barnes. Dr. Engelmann, in *Some Additions to the North American Flora*, in the *Botanical Gazette*, has described six new species, principally from California and Arizona. In the same journal Eaton has described a new cynaroid-composite, *Saussurea Americana*, from Washington Territory; E. L. Greene a number of new species from New Mexico and Arizona; Thomas Morong a new *Potamogeton Hillii*, with a figure; Vasey new grasses from Oregon, *Calamagrostis Howellii* and *Alopecurus saccatus*, and a *Trichostema Parishii* from San Diego. In the *Gazette* is a *Comparative View of the Flora of Indiana* by Coulter, and notes on *Chapmannia* and *Garberia* by A. H. Curtiss. Among the prominent papers by Meehan should be noticed an account of *Mistletoes*, and a paper on the origin of *Treeless Prairies*, which he thinks is in great part to be attributed to the burning of forests by the aborigines, both of which papers were read before the Philadelphia Academy. The *Torrey Bulletin* contains notes on *Polygala* and *Lechea* by W. H. Leggett, and a description by E. L. Greene of a new *Asclepias pinifolia* from Arizona; the *American Naturalist* two papers, by E. L. Greene, *Botanizing on the Colorado*, and by J. F. James, *Botanical Notes from Tucson*. The first part of Bebb's *Herbarium Salicum*, containing dried specimens of willows, has been issued this year.

One of the most important foreign works issued during the year was De Candolle's *Monographiæ Phanerogamarum*, vol. iii, containing 1,008 pages and 8 plates, including the following monographs: *Philydraceæ*, by Caruel; *Alismaceæ*, *Butomaceæ*, *Juncagineæ*, by Micheli; *Commelinaceæ*, by C. B. Clarke; and *Cucurbitaceæ*, comprising nearly two-thirds of the volume, by Cogniaux. The third portion of Nyman's *Conspectus Floræ Europææ*, including *Corollifloræ-Monochlamydeæ*, has also appeared this year. Three important works by Bentham, in the *Journal of the Linnean Society*, should be noticed: *Notes on Orchideæ*, *Notes on Cyperaceæ*, with special reference to Lestibaudais's *Essay on Beauvois's Genera*, and the especially valuable *Notes on Gramineæ*, in which he expresses his views with regard to the classification of grasses. Engler's *Jahrbücher* contains papers by Engler himself on the *Morphological Relations and Geographical Distribution of the Genus Rhus*, in connection with the



living and fossil allied *Anacardiaceæ*, and a contribution to the knowledge of the *Araceæ*. The third volume, parts 2 and 3, of Reichenbach's *Xenia Orchidaceæ* has been published this year. A *Synopsis of the Genus Pitcairnia* is given by Baker in the Journal of Botany. The Bot. Centralblatt contains a bibliography of the works relating to Russian plants, *Fontes Floræ Rossicæ*, by Herder. Grönlund's *Islands Flora* contains descriptions of the phænogams and vascular cryptogams, and a list of the remaining cryptogams of Iceland. Buchenau has published a *Flora of the Islands of East Friesland*; a posthumous second part of Visiani's *Flora Dalmatica* has appeared; a comparative study of the floras of Vesuvius and *Ætna* is given by Baccarini in the Giornale Botanico; Ascherson in the Bot. Centralblatt describes plants from the north of Africa; Willkomm has continued his *Illustrationes Floræ Hispaniæ*; Celakovsky has issued a *Prodromus of the Flora of Bohemia*; Hieronymus has published an account of plants collected in Patagonia under the title of *Sertum Patagonicum*. The *Reliquiæ Rutenbergianæ*, an account of the phænogams and cryptogams collected by Dr. Rutenberg in Madagascar, was elaborated by Buchenau, Engler, Haussknecht, J. Müller, Körnicke, and others, the greater part of the orders having been treated by Buchenau.

#### GENERAL.

*Die Pflanzenmischlinge*, by Focke, is an elaborate treatise on hybrids, of 519 pages, giving a catalogue of known hybrids and an account of their origin, peculiarities, and nomenclature. A new publication has appeared under the charge of Professor Eichler, called *Jahrbücher des königlichen botanischen Gartens*, which includes a history of the Botanical Garden at Berlin, with a description of recent improvements, together with original papers by the botanists attached to the garden, the most important of which have been noticed under the proper headings. A bibliographical work, entitled a *Guide to the Literature of Botany*, by B. D. Jackson, has been published in London, and includes 4,000 titles not given in Pritzel's Thesaurus. The *Traité de botanique* of Prof. Ph. Van Tieghem, of Paris, of which the earlier parts have appeared this year, is to form, when complete, a volume of about 1,300 pages. The *Botanical Collector's Handybook*, by Prof. W. W. Bailey, is the third of the Naturalists' Handy Series, published by G. A. Bates, of Salem, Mass., and contains full directions for collecting both phænogams and cryptogams.

## ZOOLOGY.

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BY THEODORE GILL.

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### INTRODUCTION.

During the past year no discoveries of previously unknown types of animals of such magnitude as signalized the year 1880 have been made, but much progress has been effected in general morphology and toward the systematic appreciation of many minor groups as well as the characteristics of various organs and structures. Investigation has been to a large extent in the same direction as it has tended to for some years past, embryology and minute anatomy receiving probably more new disciples than systematic zoology, but the latter is sure to receive new light from such special laborers. A noteworthy work that has been completed during the year—Balfour's *Introduction to Comparative Embryology*—will undoubtedly encourage as it will certainly facilitate research in that field.

The investigation of the deep-sea faunas has been continued and confirmation of previous conclusions as to the characteristics thereof has been obtained and supplemented by new discoveries. The protest which we have before made against the association of the deep-sea animals with those of the coast to which they happen to be nearest may be aptly repeated in this connection. There is no more reason, *so far as the animals themselves are concerned*, why for instance we should allocate the animals of the deep seas off the New England coast with the coast-inhabiting animals than for bringing the animals of the entire northern Atlantic into the same connection. There is in fact less reason, for there are more species and more types shared in common by the coast waters of North-eastern America and Northern Europe, than by the former and the abyssal depths within a couple of hundred miles of the coast. If it be urged that it is difficult to draw the line between the different zones, it must be remembered that it is equally difficult to establish the demarcation between contiguous littoral faunas. In a communication on the deep-sea crustaceans, Mr. Alphonse Milne-Edwards has called attention to the fact that near the Spanish coast and the Bay of Biscay are two distinct faunas neither of which would have been regarded as belonging to the same geological period nor to the same climate, and he not unnecessarily cautions geologists against too sweeping assumptions

because of the existence or non-existence of special forms in a given horizon. Contemporaneous with the peculiar types of the present epoch in the surface waters are forms of a more ancient type in the depths of the ocean which have continued with slight and only specific modifications from the secondary epoch.

Exploration during the year by the dredge, &c., has been prosecuted by the Italian and French Governments, and to some extent by the United States Fish Commission. An Italian expedition was equipped for the investigation of the Mediterranean with Captain Magnaghi as commander, he also assuming the physical investigations, while Prof. Enrico H. Giglioli, the well-known naturalist of Florence, took charge of the biological work. The last previous deep-sea exploration of that sea had been conducted by the British vessel Porcupine in the year 1870.

The means for education and investigation in the form of sea-side laboratories have also been increased. Those which in this country have been especially justified by their works are that of the United States Fish Commission, at Wood's Holl, Mass., and that of the Johns Hopkins University, at Beaufort, N. C., under the directorship of Dr. J. K. Brooks. In France a new laboratory has been constructed under the direction of the eminent biologist de Lacaze-Duthiers, at Port Vendres, on the Mediterranean, the municipal authorities thereof having secured it by providing a building and boat as well as a capital sum of 32,000 francs, and in addition an income of 750 francs per annum.

A partial bibliography of noteworthy memoirs and works relating to different classes of animals is supplied in the present article, and will, it is hoped, prove to be of use to those to whom the voluminous bibliographies and records of progress in science are inaccessible. It has been a difficult matter to select the titles which might be most advantageously introduced in a limited report like the present. Articles of a general interest or of special importance as contributing to throw light on the affinities of certain groups have been given the first place. Necessarily many very important papers have not been referred to and very few descriptive of species have been admitted and only when unusual interest attaches to the new species or the groups which they enlarge.

The compiler desires to make special acknowledgment for most material assistance to the *Zoologischer Anzeiger* of Professor Carus and to the *Journal of the Royal Microscopical Society*, whose abstracts of investigations have been freely drawn upon in the preparation of those for the present report. The *Zoologischer Anzeiger* is so useful to every working naturalist that it is a matter of deep regret that an index of the authors whose articles are catalogued as well as subjects treated in those articles is not given with the close of each volume. The want of such an index greatly lessens the value of the work for constant use and hours may be consumed in finding a reference remembered as to existence but whose exact place is forgotten.

## GENERAL ZOOLOGY.

## HISTORICAL ZOOLOGY.

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- Bibliotheca Historico-naturalis, physico-chemica et mathematica, oder systematisch geordnete Uebersicht der in Deutschland und dem Auslande auf dem Gebiete der gesammten Naturwissenschaften, etc., erschienenen Bücher.* Herausgegeben von F. Frenkel. 30. Jahrg. Göttingen, Vandenhoeck & Ruprecht, 1881. (8vo. M. 1.20.)
- Zoological (The) Record for 1880, being Vol. XVII of the Record of Zoological Literature.* Edited by Edw. Caldwell Rye. London, Van Voorst, 1881. (8vo. xxiv, 31 49, 13, 23, 123, 61, 30, 8, 238, 15, 11, 23, 23, 22, 12 pp.)
- Zoologischer Anzeiger.* Herausgegeben von Prof. J. Victor Carus. IV. Jahrgang, 1881. Leipzig, W. Engelmann, 1881. (8vo.)
- Zoologischer Jahresbericht für 1880.* Herausg. von der zoologischen Station zu Neapel. Red. von J. Victor Carus. I. Abth. Allgemeines bis Vermes. II. Abth. Arthropoda. III. Abth. Tunicata, Mollusca. IV. Abth. Vertebrata. Leipzig, Engelmann, 1881. (8vo. I=ix, 383 pp., M. 10; II=iv, 435 pp., M. 10; III=116 pp., M. 3; IV=293 pp., M. 8.)

## SCIENTIFIC DIRECTORY.

- International (The) Scientists' Directory.* Containing the Names, Addresses, Special Departments of Study, etc., of Amateur and Professional Naturalists, etc., etc., in America, Europe, Asia, Africa, and Oceanica. Compiled by Sam. E. Casino. Boston: S. E. Casino. 1882. (8vo, viii, 391 pp.)

## SYSTEMATIC ZOOLOGY.

- Brehm's Thierleben.* Mit 170 Tafeln in Farbendruck, unter Leitung der Zoologen Dr. Girtanner, Klunzinger, O. Schmidt und Taschenberg nach dem Leben ausgeführt vom Maler Olof Winkler. 4 Bd., 1—7 Heft, = p. 1—384. Vögel. Leipzig, Bibliogr. Instit., 1881. (8vo. M. 1 each.)
- Bronn's Klassen und Ordnungen des Thierreichs.* 1 Bd. Protozoa, neu bearbeitet von O. Butschli. 3, 9 Lief.—5 Bd., Abth. Gliederfussler, Arthropoda, von Ad. Gerstaecker. 1., 2., 3., Lief.—6 Bd., 3 Abth. Reptilien, von C. K. Hoffmann. 18.—26. Lief. Leipzig, C. F. Winter'sche Verlagsahandlung, 1881. (8vo. M. 1.50 each.)
- Claus (C.) Grundzüge der Zoologie.* 4 Aufl. 2 Bd. Marburg, Elwert, 1881. (8vo. M. 8.)
- Edwards (Alphonse Milne). Éléments de l'histoire naturelle des animaux.* P. I. Zoologie méthodique et descriptive. Paris, 1882. (8vo, 391 pp. 487 fig.—published Nov., 1881.)
- Gervais (Paul). Cours élémentaire d'histoire naturelle.* 1. Partie: Zoologie pour l'enseignement dans la classe de cinquième. Paris, Hachette, 1881. (12mo, 408 pp., 240 fig.)  
(Cours d'études scientifiques à l'usage des Lycées et des Collèges.)
- Hagelberg (W.) Zoologischer Handatlas.* Berlin: Dümmler, 1881. (4to.)  
C. D. Amphibien und Fische. (M. 5)  
E. Gliederthiere. (M. 5.)  
F. G. Mollusken und Würmer, Stachelhäuter, Strahlthiere und Urthiere. (M. 3.)
- Leuckart (Rudolf) und H. Nitsche. Zoologische Wandtafeln zum Gebrauche an Universitäten und Schulen.* 4. Lief. Taf. X—XI. Cassel, Fischer, 1881. (M. 5.)

- MacAlpine (D.) *Zoological Atlas* (including comparative anatomy). Vertebrata. London, W. & A. K. Johnson, 1881. (4to. 231 col. fig.)
- Pagenstecher (H. Alex.) *Allgemeine Zoologie*. 4. Theil. Harnabsonderungsorgane und Haut. Mit 414 Holzschn. Berlin, P. Parey, 1881. (8vo, viii, 959 pp. M. 21.)

## FOREST ZOOLOGY.

- Altum (B.) *Forstzoologie*. III. Insecten. I. Abth. Allgemeines und Käfer. 2. Aufl. Berlin, Springer, 1881. (8vo, vii, 380 pp. M. 8.)

## ZOOTOMY.

- Bruhl (C. B.) *Zootomie aller Thierklassen für Lernende nach Autopsien skizzirt*. Atlas in 50 Liefgn. zu 4 Taf. Lief. 21—24. Wien, A. Hölder, 1881. (4to. M. 4 each.—These relate to the anatomy of Cephalopoda.)
- Edwards (H. Milne). *Leçons sur la Physiologie et l'Anatomie comparée de l'homme et des animaux*. T. 14 (dernier). Fonctions de relation (fin); Considérations générales; Table générale des Matières. Paris, Masson, 1881. (8vo, 534 pp.)
- Mojsisovics, *Edl.* von Mojsvar (A.) *Manuel de Zootomie, guide pratique pour la dissection des animaux vertébrés et invertébrés, etc.* Trad. de l'allemand par J. L. de Lanessen. Avec 128 fig. Paris, Doin, 1881. (8vo, 376 pp. Frcs. 9.)
- Ranvier (L.) *Leçons d'Anatomie générale faites au Collège de France*. (Année 1828-'29. Terminaisons nerveuses sensitives; cornée.) *Leçons recueill.* par M. Weber, revues par le professeur. Paris, J. B. Baillière et fils, 1881. (8vo, xx, 447 pp., 50 figs. Frcs. 10.)

## EMBRYOLOGY.

- Balfour (F. M.) *A Treatise on Comparative Embryology*. Vol. 2. London, Macmillan, 1881. (8vo. 21 sh.)
- Goette (Alex.) *Abhandlungen zur Entwicklungsgeschichte der Thiere*. 1. Heft. *Untersuchungen zur Entwicklungsgeschichte der Wurmer*. Beschreibender Theil. Leipzig, L. Voss, 1882. (8vo, 164 pp. 6 pl., M. 15.)

## SYSTEMATIC PALEONTOLOGY.

- Zittel (Karl A.) *Handbuch der Paläontologie*, unter Mitwirkung von W. Ph. Schimper. 1. Bd., 2. Abth., 1. Lief. München und Leipzig, Oldenbourg, 1881. (8vo. M. 7.)

## EVOLUTION, ETC.

- Haeckel (E.) *Les preuves du transformisme; réponse à Virchow*. Trad. et précédé d'une préface par Jules Soury. 2. éd. Paris, Germer-Baillière & Cie., 1881. (18mo, xxxvi, 159 pp.)
- Perrier (Edmond). *Les colonies animales et la formation des organismes*. Paris, G. Masson, 1881. (8vo, xi, 978 pp.)
- Roux (Wilhelm). *Der Kampf der Theile im Organismus*. Ein Beitrag zur Vervollständigung der mechanischen Zweckmässigkeitslehre. Leipzig, W. Engelmann, 1881. (8vo, viii, 244 pp. M. 4.)
- Weismann (Aug.) *Studies in the Theory of Descent*. Translated and edited by Raph. Meldola. P. II. On the origin of the markings of Caterpillars, and on Phyletic Parallelism in Metamorphic Species. London, Sampson, Low & Co. 1881. (8vo.)
- Wilson (Andr.) *On the Origin of Colonial Organisms*. *Ann. and Mag. of Nat. Hist.*, (5,) v. 7, pp. 413-416.

## TAXIDERMY, ETC.

- Martin (Philipp L.) Die Praxis der Naturgeschichte. 3 Theile. Naturstudien. 2. Hälfte. Allgemeiner Naturschutz. Einbürgerung fremder Thiere und Gesundheitspflege gefangener Säugethiere und Vögel. Bearbeitet von Ph. L. Martin und Sohn. Die Pflege gefangener Reptilien und Amphibien, nebst Pflege und Züchtung der Makropoden. Bearbeitet von Bruno Dürigen. Weimar, B. F. Voigt, 1882. (8vo, xv, 210 pp. M. 5.)

## EXPEDITIONS AND FAUNAS.

*General.*

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- Thomson (Sir C. Wyville), *editor*. Report of the Scientific Results of the Voyage of H. M. S. "Challenger" during the years 1873-76, under the Command of Capt. Geo. Nares and Capt. Frank Turle Thomson. Prepared under the superintendence of Sir C. Wyville Thomson. Zoology. Vol. 2. London, Longmans, 1881. (4to. 50sh.)

*Arctic Regions.*

- Norske (Den) Nordhavs-Expedition. Zoologi. Fiske, ved Rob. Collet. Med 5 pl., 3 Tracsn. og 1 Kart. Christiania, 1880. (Published Apr., 1881. gr. 4to.)

*North America.*

- Verrill (A. E.) Notice of the remarkable Marine Fauna occupying the outer banks of the Southern coast of New England. (=Brief Contributions to Zoology from the Museum of Yale College. No. XLVIII.) *Amer. Journ. Sc.*, (3,) v. 22, pp. 292-303.

*Europe.*

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- Krukenberg (C. F. W.), *editor*. Vergleichend-physiologische Studien an den Küsten der Adria. 4. Abth. Nebst anatomischen Mittheilungen von Graf B. Haller und E. Berger in Wien. Mit 4 lith. Taf. Heidelberg, C. Winter's Universit.-Buchhandl., 1881. (8vo. M. 5.)
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- II. Monographie: Fierasfer von Dr. Carlo Emery. Mit 9 Taf. u. 10 Holzschn. Leipzig, Engelmann, 1880. (4to. M. 25.)
- III. Monographie: Pantopoda von Dr. Ant. Dohrn. Mit 18 Taf. in Lithographie. Leipzig, Engelmann, 1881. (4to, viii, 252 pp.)
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*Africa.*

Rolland (G.) Sur les Poissons, Crabes et Mollusques vivants, rejetés par les puits artésiens jaillissants de l'Oued Rir' (Sahara de la province de Constantine). *Compt. rend. Acad. Sc., Paris*, t. 93, pp. 1090-1093.

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Küchenmeister (F.) und F. A. Zürrn. Die Parasiten des Menschen. 2. Aufl. 3. Lief. Nematoden. Insecten. Leipzig, Abel, 1881. (8vo. M. 10.)

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Zürrn (F. A.) Die Schmarotzer auf und in dem Körper unserer Haussäugethiere. In zwei Theilen. I. Th. Die thierischen Parasiten. 2. Aufl. Mit 4 Taf. Weimar, Voigt, 1882. (Nov. 1881-8vo, xvi, 316 pp. I M. 6.)

## MISCELLANEOUS.

Aristotle on the Parts of Animals. Translated, with Introduction and Notes, by W. Ogle. London, Paul Kegan & Co., 1882. (8vo, 280 pp. 12s. 6d.)

Brandt (K.) Symbiose niederer Tiere mit Algen. *Verhandl. Physiolog. Ges.* Berlin, 1881.

Garrod (A. H.) Collected Scientific Papers. Edited by W. A. Forbes. London, 1881. (8vo, 527 pp., with portr. and pl. £1 1s.)

## MYCETOZOANS.

Kent (W. Saville). The Myxomycetes or Mycetozoa, Animals or Plants? *Pop. Sc. Rev.*, n. s., v. 5, pp. 97-116, pls. 3, 4, April, 1881.

*Animals or Plants?*

Among the lowly organisms whose place in the kingdoms of organic nature has not even yet been certainly decided are certain forms which were long regarded as gasteromycetous fungi, represented, *e. g.*, by *Æthaliium septicum*, a notorious hot-house pest. Mr. M. J. Berkeley, an eminent authority on the lower plants, in 1857, in his Introduction to Cryptogamic Botany, defined them as follows:

"Whole plant at first gelatinous. Mycelium often vein-like, forming reticulated or anastomosing strata, but sometimes diffuse, giving rise to sessile or stipitate, free or confluent peridia, consisting of one or more membranes, inclosing, when mature, a dry mass of threads or plates and spores; at length often bursting: threads of various structure, sometimes containing one or more spirals."

The forms of these groups, according to Mr. Berkeley, are remarkable for "their indifference as to the matrix upon which they grow. The same species may occur on plants of the most distant natural affinities, and on other matrices. One species was observed by Schweinitz to be developed on iron which had been heated in a forge only a few hours previously. Like algæ, they appear to derive their nutriment from the surrounding medium, and not from the matrix to which they are attached."

Such are the most prominent morphological and physiological features of the group in question. No suspicions had ever been entertained as to their existence as plants until a discovery by Dr. A. De Barry, about the year 1859. That naturalist investigated the development of these organisms. "The spores, on careful cultivation, were found to give rise not to jointed cellular hyphæ, but to *flagellate monadiform germs, possessing locomotive faculties*, a spheroidal nucleus or endoplast, one or more contractile vacuoles, and the faculty of *ingesting solid food substances*. After a short interval these germs, retracting their flagella, assumed an amœboid repent phase, and, coalescing freely with their neighbors, built up the so-called gelatinous or pulpy masses out of which the sporangia, or peridia, were developed." In view of such manifestations, Dr. De Barry deemed himself forced to the conclusion that the so-called plants could no longer be properly regarded as such, but that they were members of the animal kingdom, and he consequently preferred to change the name of *Myxomycetes* to *Mycetozoa*, and thus indicate by the name the supposed facts in the case. The observations of De Barry were essentially confirmed in 1862 by L. Cienkowski, and still further extended by himself in 1864 in a special monograph of the *Mycetozoa*.

Nevertheless, botanists have been loath to give up the group, and while some have retained it among plants rather for the sake of convenience than conviction as to the plant-like nature of its species, others have bitterly resented the attempt to transfer the type from the vegetable to the animal kingdom. Whether such forms are animals or plants has been a subject of controversy lately between Mr. Saville Kent, a well-known student of the infusoria, and Dr. M. C. Cooke, an enthusiastic cryptogamist. Mr. Kent has presented the argument in favor of the animal nature of the group, and Mr. Cooke, while not denying the facts epitomized, denies that they prove the organisms so distinguished to be animals, and still claims that they are of a "truly vegetable nature." Another eminent cryptogamist, M. Van Tieghem (*Bull. Soc. Bot. France*, v. 27, pp. 317-322) also considers the problematic organisms to be plants, and even that the forms brought together as *Myxomycetes* exhibit so much heterogeneity that they cannot be naturally associated together, but should be dispersed and correlated with various diverse fungi, which they most resemble in what he calls their fructification. It may be added, in this connection, that Van Tieghem divides the *Myxomycetes*, as he naturally calls them, into three groups: (1) those with the *plasmodium* fused and endosporous—*Myxomycetes* restricted; (2) those with the *plasmodium* also fused, but exosporous—*Ceratiaceæ*; and (3) those with the *plasmodium* aggregated—*Acrasiaceæ*.

Some eminent zoologists (*e. g.*, Dr. Claus) also are disposed to or actually do repudiate the organisms in question as animals.

When such authorities differ we will not presume to offer an opinion.



That the characteristics of the organisms in their mature state are those of plants, the universal consensus of botanists indicates; that the embryonic condition at least simulates or even is essentially identical with the amœbiform animals seems to be almost equally certain. Those who knew the entities only in their adult stage would not question their vegetable nature; those who might be acquainted with them only in their embryonic condition would as little question their animal nature, provided that the protozoans were conceded to be animals. Apparently, therefore, they are animals in the earlier period of their existence, and plants in the latter. The question then seems to be whether it shall be admitted that the same organisms may really belong to different kingdoms at different stages, or whether the pertinence to either shall be decided by the features exemplified in the embryo or the mature. Naturalists will recall how strong is the evidence as to affinities furnished by development in the animal kingdom, and how by it questions that would be otherwise obscure or insoluble have been completely elucidated. Embryological characters are *generally* most persistent. On the other hand, important changes and modifications may supervene in the early stages of an organism while the adult remain comparatively unchanged.

#### *Symbiosis of Plants and Animals.*

Several very interesting and remarkable cases of consociation and interdependence between plants and animals have been recorded by Dr. K. Brandt.

At one time chlorophyll was regarded as a peculiar and distinctive constituent of plants, but it has now long been known as an element occurring also in certain inferior animals. That the chlorophyll had something to do with active vegetation in the animal organism had been suspected, but the exact relations at least were unknown. Carl Semper, it seems, approached the truth when he suggested that the chlorophyll particles were of the nature of vegetation commensal with the animal. Commensalism, however, fails to express the interrelation between the two. The green particles are truly unicellular plants, and they have been discovered under minor modifications in very different animals—infusoria of various kinds, sponges (*Spongilla*), acalephs (*Hydra*), planarians (a fresh-water species). The investigations and experiments conducted by Dr. Brandt and communicated to the Physiological Society of Berlin may be said, in brief, to have established the following facts: On the one hand, the algæ elaborate organic matter from inorganic and utilize the waste products of the animal. On the other hand, the animals forsake an independent life so far as capture and ingestion of food is concerned, and are sufficiently nourished by the plants which have found a home in their bodies.

Such a relationship cannot properly be said to be one of parasitism or commensalism. The consociation of the two is mutually advantageous, and an interdependence is established between them. The pecu-

liar relationship has been designated *Symbiosis*, and is justly regarded by Dr. Brandt as one of the most remarkable phenomena in nature. Morphologically, the algæ are parasites; the animals are physiologically.

The symbiotic plants are developed under two so-called generic modifications (*Zoochlorella* and *Zooxanthella* are the names conferred on them) and several species. (J. R. M. S. 2, I., 241-4.)

### *The telegraph and animal life.*

Certain manifestations of animal life have been co-ordinated with the effects of the telegraph, by Nielson, director of the Norwegian telegraph system. The telegraph posts in the pine region, even when sulphate of copper has been applied, have been pecked into by woodpeckers, especially near the insulators, and it is assumed that this has resulted from the birds mistaking the sonorous vibration of the wires for insect sounds. Bears, too, are attracted by the sounds, and disturb the stones which are heaped around the poles, in their endeavors to get at the bees whose humming is simulated by the vibrations. On the other hand, wolves are said to be frightened away by the sound of the wires, and a member of the Storthing, or Norwegian parliament, voted for a grant to a telegraph line, not because the line would be of direct use to his constituents, but because the wolves would be thereby frightened away. We register these observations without any indorsement of our own.

## PROTOZOANS.

### GENERAL.

Balbani (E. G.) *Les Organismes Unicellulaires. Les Protozoaires. Leçons faites au Collège de France. Journ. de Microgr.*, 5. ann., pp. 63, 116, 156, 203, 257, 292, 321, 357, 388, 435.

Bütschli (O.) *Protozoa. Neu bearbeitet.* 2.—7. Lief. Leipzig, C. F. Winter, 1881. (Bronn's Klassen und Ordnungen.—8vo. Each Lief. M. 1.50.)

Kent (William Saville). *A Manual of the Infusoria, including a description of all known Flagellate, Ciliate, and Tentaculiferous Protozoa, British and Foreign, and an account of the organization and affinities of the Sponges.* London, 1880-1881. (8vo.)

Maggi (Leop.) *Intorno ai Protisti ed alla loro classificazione. II. Della classificazione dei Protisti. Boll. Scientif., anno 3*, pp. 16-23.

Ryder (J. A.) *Occurrence of the same species of Protozoa on both sides of the Atlantic. Proc. Acad. Nat. Sc. Phila.*, 1881, p. 442, 443.

### SPECIAL GROUPS.

#### *Pulsatoria.*

Geddes (Patrick) *Sur une nouvelle sous-classe d'Infusoires. Compt. rend. Acad. Sc., Paris*, t. 93, 1085-1087.

#### *Rhizopoda.*

Bütschli (O.) *Beiträge zur Kenntniss der Radiolarienskellette, insbesondere der der Cyrtida. Zeitschr. f. wiss. Zool.*, v. 36, pp. 485-540.

Haeckel (Ernst). *Entwurf eines Radiolarien-Systems auf Grund von Studien der Challenger-Radiolarien. Jena. Zeitschr. f. Naturwiss.*, v. 15, pp. 418-472.

*Tentaculifera.*

Maupas (E.) Contributions à l'étude des Acinétiens. *Arch. Zool. Expér.*, t. 9, pp. 299-368.

*Kent's classification of the Protozoans.*

A new classification of the Protozoans having several novel features, and disregarding views now quite generally prevalent, has been proposed by Mr. W. Saville Kent in a "Manual of the Protozoa." Of the "sub-kingdom" in question, four classes are admitted and systematically treated, viz:

(1.) PANTOSTOMATA, without a true oral orifice, the food being indifferently ingested through the surface. The groups referable to this class are the Amœbina, Gregarinida, Foraminifera, Radiolaria, and restricted Flagellata.

(2.) DISCOSTOMATA, without a true oral orifice, but raking in their food within the limits of a discoidal area occupying the anterior extremity of the body. Its groups are the "Choano-flagellatæ" (collar-bearing Flagellatæ) and the Spongiida.

(3.) EUSTOMATA, having a true mouth and containing the greater part of the infusoria, viz: Ciliata, Cilio-flagellata, and "such Flagellata as *Euglena* and *Chilomonas*."

(4.) POLYSTOMATA, "with tentacle-like organs radiating from the periphery, each of which serves as a tubular sucking-mouth or for grasping food," including the "Suctorial animalcules or Tentaculifera of Huxley (*Acineta*, &c.)."

It will be thus seen that the old view as to the relations of the sponges is still adhered to and the interpretation of the facts from the light of development is rejected. (J. R. M. S., 2, I, 615-616.)

*Transparent Animalcules.*

The waters of Lake Maggiore and the spring of Valcuvia have been recently examined by Professor Maggi, and by various coloring and hardening re-agents a number of forms not otherwise visible have been revealed under the microscope. These have been collectively designated as Aphaneri (not evident) and contrasted with the Phaneri (evident), which term designates the bacteria and other minute organisms visible under the microscope without re-agents. The Aphaneri are thought to be harmless. It is proposed to supply the city of Milan with water from the lake.—(*Nature*, v. 25, p. 348.)

*A new primary Group of Infusorians.*

In the mesoderm of a certain Planarian worm (*Convoluta schulzei*) occur cells which are about the size of the red blood corpuscles of a frog, and which are of a curved pyriform shape, and have a large central vacuole filled with fluid. From the wall of this cavity, towards the convex side of the cell, arise homogeneous transparent fibrillæ in a row which is almost parallel with its principal axis. These cells, when free in salt-water, manifest a rhythmical contractility, "the rapidity and vigor of which are equally surprising, the most active pulsating from 100 to

180 times per minute." Mr. Patrick Geddes' investigation of these bodies convinced him that they were parasitic infusorians with such well-marked characteristics as to warrant their distinction as a peculiar primary group (which he called a "sub-class") co-ordinate with the Suctoria ciliata and Flagellata, and which he has named Pulsatoria. They deviate from the infusoria generally by the suppression of the cilia (which would not be available for locomotion among the cells of the mesoderm) and the differentiation of the contractile vesicle. "This differentiation," it is added, "is certainly very remarkable from every point of view when we consider the relatively enormous size of the vacuole, the development of the contractile fibers which limit it, or the rapidity of their contraction." The new type has received the specific name *Pulsatella convolutæ*. Other Planarians were searched for similar organisms, but without success. (J. R. M. S. 2, II, 204-205, from *Comptes Rend. Acad. Sc.*, XCIII, 1085-1087.)

## PORIFERS.

## GENERAL.

Schulz (Frz. Eilh.) Untersuchungen über den Bau und die Entwicklung der Spongien.—10 Mittheil. *Corticium candelabrum* O. Schm. *Zeitschr. f. wiss. Zool.*, v. 35, pp. 410-430.

## SPECIAL GROUPS.

*Fibrosa.*

Carter (J. H.) History and Classification of the known species of Spongilla. *Ann. & Mag. Nat. Hist.*, (5,) v. 7, pp. 77-107, 2 pl.

Dybowski, (W.) Einige Bemerkungen über die Veränderlichkeit der Form und Gestalt von *Lubomirekia baicalensis* und über die Verbreitung der Baikalschwämme im Allgemeinen. *Bull. Acad. Sc. St. Pétersb.*, v. 31, pp. 45-50; *Mélang. biolog.*, v. 11, pp. 41-47.

Potts (E.) Some new Genera of Fresh-water Sponges. *Proc. Acad. Nat. Sc. Phila.*, 1881, pp. 149-150.

Schulze (F. E.) Sur la structure et la disposition des parties molles de l'Euplectella aspergillum. *Arch. Zool. Expér.*, t. 9, Notes, etc., p. xxvii.

*Camaraphysemidæ.*

Ryder (John A.) On Camaraphysema, a new type of Sponge. *Proc. U. S. Nat. Mus.*, v. 3, p. 269-272.

## FOSSIL SPONGES.

Whitfield (R. P.) Observations on the Structure of Dictyophyton and its affinities with certain Sponges. *Amer. Jour. Sc.*, (3,) v. 22, pp. 53-54; *Ann. & Mag. Nat. Hist.*, (5,) v. 8, pp. 167-168.

— On the Nature of Dictyophyton. *Amer. Journ. Sc.*, (3,) v. 22, p. 122; *Ann. & Mag. Nat. Hist.*, (5,) v. 8, pp. 237.

## APPENDIX.

*Parasites.*

Carter (H. J.) On Spongiophaga in Spongilla. *Ann. & Mag. Nat. Hist.*, (5,) v. 8, p. 222.

Duncan (P. Mart.) On an Organism which penetrates and excavates siliceous Spongicula (*Spongiophaga Carteri*). *Ann. & Mag. Nat. Hist.*, (5,) v. 8, p. 120-122.

*Peculiar Palæozoic Sponges.*

In rocks of the Devonian period and of the Chemung group of New York, the Waverly beds of Ohio, and the Keokuk beds of Iowa and Indiana, are found certain problematical fossils to which the generic names *Hydnoceras*, *Dictyophyton*, and *Uphantænia* have been given. These fossils have been supposed by most palæontologists to have been plants related to the algæ. Mr. R. P. Whitfield, of New York, has recently sought to ascertain their affinities, and has come to the conclusion that they were, in fact, of sponge origin. His later researches were seconded by Principal Dawson, of McGill University, who now entertains the same opinion. The organisms in question are more or less elongated tubes, and "have been composed of a thin film or pellicle of net-work made of longitudinal and horizontal threads which cross each other at right angles"; when carefully examined "one set appears to pass on the outside and the other on the inside of the body." A *Uphantænia* from Indiana, which was later examined, exhibited the original structure better and "retained the substance of the organism. Under a hand-glass of moderate power it is seen to have been composed of cylindrical threads of various sizes, now replaced by pyrite." It had broad, radiating bands, and between them narrow, thread-like bands as well as "circular," narrow or thread ones. "The broad bands are composed of very fine thread-like spicules, and the narrow ones of much stronger ones, while the thin film occupying the intermediate spaces is composed of still smaller spicules, apparently arranged in radiating manner." According to Principal Dawson, viewed as opaque objects, "the reticulating bands are seen to be fascicles of slender cylindrical rods or spicules," and the spicules are "usually cylindrical and smooth," but occasionally taper gently to a point. "In their present state they appear as solid, shining rods of pyrite." It is aptly added, that "the most puzzling fact" is "the mineral condition of the spicules, now wholly replaced by pyrite." Nevertheless, "the study of the specimen" in question "inclined" Principal Dawson "to regard it as more probably a sponge" than as a fucoid, as he had previously supposed. (A. J. S., (3,) XXII, pp. 53-54; 132-133.)

Subsequently, Mr. C. D. Walcott re-examined a fossil from the Utica slate, which he had described in 1879 as an alga, under the name *Cyathophycus*, and now considers it likewise to have been a sponge. It exhibited the same general features of structure as the *Hynoceratidæ* and the spicules in it, too, had been all apparently replaced by pyrite. (A. J. S., (3,) XXII, pp. 394-395.) All the fossils referred to have been compared, as to structure, with *Euplectella*, and it has been said that they exhibited the greatest similarity to that genus, but doubtless it was meant in a general manner, and not, as might be inferred, that there was any intimate relationship, or, in fact, closer affinity between the forms discussed and the recent genus than with the living relatives of the last.

*Propagation of Sponges.*

Some observations, interesting from a physiological as well as practical point of view, have been published by Dr. E. von Marenzeller, respecting the propagation of sponges. The investigations in question were made in 1863 and 1872, in the Bay of Socolizza, under the auspices of the Austro-Hungarian Government, with a view to the improvement of the sponge crop of the Adriatic; but, strange as it may seem, they were regarded with a determined hostility by the inhabitants of the region. This antagonism materially interfered with the investigation, but enough was learned to suggest that, under favorable auspices, sponge-culture could be successfully carried on. Winter is the most suitable season for the experiment; clear and sheltered bays the best place. The sponges for propagation should be carefully gathered, and the cuttings may be best made with a very fine saw. The best size for the cuttings is about a cubic inch. Such pieces, consigned to the water, speedily attach themselves to the surface with which they come into contact, especially if the cut surface is applied. For fuller details reference is made to the *Journal of the Society of Arts* (v. 29, pp. 592-594) and the *Journal of the Royal Microscopical Society* (2, v. 1, pp. 748-751).

## COELENTERATES.

## GENERAL.

Chun (C.). Die Natur und Wirkungsweise der Nesselzellen bei Coelenteraten. *Zool. Anz.*, 4. Jahrg., pp. 646-650.

## SPECIAL CLASSES.

## POLYPS.

Andres (Aug.). *Prodromus Neapolitanæ Actiniarum Faunæ, addito generalis Actiniarum bibliographiæ catalogo.* *Mittheil. zoolog. Station Neapel*, v. 2, pp. 305-371.

## ACALEPHS.

## 1. General.

Guerne (Jul. de). Méduses d'eau douce et d'eau saumâtre. *Bull. Sc. Dépt. du Nord*, 1880 (publ. 1881), pp. 417-424.

Haeckel (Ernst). *Monographie der Medusen.* 2. Th. Die Tiefsee-Medusen der Challenger-Reise. Der Organismus der Medusen. Mit 32 Kupfertaf. und 8 Holzschn. Jena, G. Fischer, 1881. (4to M. 46.)

Romanes (George J.). Concluding remarks on the locomotor system of Medusæ. *Philos. Trans. Royal Soc. London*, v. 171, pp. 161-202.

———. Medusæ and Hydroid Polyyps living in Fresh Water. *Quart. Journ. Mic. Sc.*, v. 21, pp. 162-165.

## 2. Special orders.

*Hydroidea.*

Claus (C.). Ueber *Aequorea Forskalea* Esch. als *Aequoride* des adriatischen Meeres, zugleich als Kritik von E. Haeckel's *Aequoridensystem.* *Arbeit. Zoolog. Instit. Wien*, v. 3, pp. 283-312, 1881.

Lankester (E. Ray). On young stages of *Lymnocodium Geryonia.* *Quart. Journ. Micr. Soc.*, v. 21, pp. 194-201, 1 pl.

*Siphonophora.*

Chun (C.). Das Nervensystem der Siphonophoren. *Zool. Anz.*, 4. Jahrg., pp. 107-111: Fewkes (J. Walter). The Siphonophores. II. The Anatomy and Development of Agalma—continued. *Am. Naturalist*, v. 15, pp. 186-195.

*Phanerocarpa.*

Haeckel (E.). Organisation und Classification der Acraspeden. *Jena. Zeitschrift f. Naturw.*, v. 14, *Suppl.-Heft*, pp. 20-29.

———. Classification der Discomedusen. *Jena. Zeitschrift f. Naturw.*, v. 14, *Suppl.-Heft*, pp. 51-54.

*Medusæ and Hydroid Polyps living in fresh water.*

Mention was made in the Smithsonian Report for 1880 of the occurrence of various medusiform acalephs in fresh water, and the change in our ideas as to their adaptability for life in such a medium which the facts entailed. "The tolerance by Medusæ belonging to marine species of fresh water under natural conditions was observed by Mr. Mosely, at Brower's Creek, in New South Wales" (*Naturalist on the Challenger*, p. 272), and Mr. A. Agassiz communicated analogous instances observed near Boston in a letter to Prof. E. Ray Lankester (*Quart. Journ. Micr. Sc.*, n. s., v. 20, pp. 483-485). Mr. George J. Romanes has experimented on *Sarsia* with reference to its tolerance of change, and recalled that Prof. L. Agassiz made a partial experiment in 1850, and found that a *Sarsia* transferred directly from salt water into a glass of fresh "will at once drop like a ball to the bottom and remain forever motionless—killed instantaneously by the mere difference of density of the two media" (*Mem. Am. Acad. Arts and Sc.*, 1850, p. 229). Mr. Romanes, however, found that while the *Sarsia* did really drop down as described, instantaneous death did not ensue, but if transferred back into salt water within five or ten minutes the *Sarsia* would revive and regain full vigor, but if allowed to remain in the fresh water as long as fifteen minutes recovery never ensued. Mr. Romanes also sought to ascertain whether the collapse of the *Sarsia* in fresh water was the result of a difference of density, and his experiments, although not conclusive, appeared to indicate that it was not, but rather, perhaps, due to the absence of the chemical constituents of its natural medium. It is to be borne in mind that these experiments were on the abrupt transfer from the one medium to the other. As to the cases cited of the living of salt-water species in fresh water, Mr. Romanes "can only conclude from it that a gradual transition from salt to comparatively fresh water, not giving rise to such rapid osmosis" as takes place in case of abrupt change, "is not so injurious to Medusæ" as he should have suspected. He adds that "the whole subject is thus shown well worthy of further experimental inquiry." (*Quart. Journ. Micr. Sc.*, n. s., v. 21, pp. 162-165; *Phil. Trans. Royal Soc.*, v. 167, p. 744, etc.)

## ECHINODERMS.

## 1. GENERAL.

*Morphology.*

Romanes (G. J.) and J. C. Ewart. Locomotor system of Echinodermata. *Nature*, v. 23, pp. 545-547.

*Fauna.*

Duncan (P. M.) and W. Percy Sladen. A Memoir of the Echinodermata of the Arctic Sea to the west of Greenland. London, Van Voorst, 1861. (fol. 10s 6 d)

## 2. SPECIAL ORDERS.

*Blastoidea.*

Carpenter (P. Herbert). On certain points in the Morphology of the Blastoides. *Ann. Mag. Nat. Hist.*, (5,) v. 8, pp. 418-424.

*Crinoidea.*

Carpenter (P. Herbert). The minute Anatomy of the Brachiote Echinoderms. *Quart. Journ. Micr. So.*, v. 21, pp. 164-193, 2 pl.

Carpenter (P. H.). On two new Crinoids from the Upper Chalk of Southern Sweden. With 1 pl. *Quart. Journ. Geol. Soc. London*, v. 37, pp. 128-136.

Wachsmuth (Charles) and Frank Springer. Revision of the Palæocrinoidea. P. II. Family Sphæroidocrinidæ. *Proc. Acad. Nat. Sc. Phila.*, 1881, pp. 177-414, 3 pl.

*Echinoidea.*

Bell (F. Jeffrey). Observations on the characters of the Echinoidea. IV. The Echinometridæ: their Affinities and Systematic Position. *Proc. Zool. Soc. London*, 1881, pp. 410-433.

Loriol (P. de). Monographie des Échinoides contenus dans les couches nummulitiques de l'Égypte. *Mém. Soc. Phys. et d'Hist. Nat. de Genève*, v. 27, pp. 59-146, 2 pl.

*Ophiuroidea.*

Lyman (Theodore). The stomach and genital organs of Astrophytidæ. *Bull. Mus. Comp. Zool.*, v. 8, pp. 117-125, 2 pl.

*Holothuroidea.*

Ludwig (Hub.). Revision der Mertens-Brandt'schen Holothurien. *Zeitschr. f. wiss. Zool.*, v. 35, pp. 575-599.

*The star-fishes and diagnostic formulæ for them.*

The genus containing the common star-fish of the coasts of the New England and Middle States, has been re-examined by Prof. F. J. Bell. The name *Asterias* is retained for the genus, and 79 species are admitted as distinct. These are distributed under several successively narrowed series of groups, and a peculiar diagnostic system or formula is proposed to make known in terse form the various combinations of characters. They are distinguished (1) by the number of rays, whether five (*pentactinida*) or more (*heteractinida*); then (2) by the number of



madrepore plates, whether one (*monoplocid*) or more (*polyplacid*); (3) the number of spines bordering the ambulacra, these being in some uniserial (*monacanthida*), and in others biserial (*diplacanthida*); (4) some have the madrepore plate, with a circle of spines (*echinoplacida*), and others are destitute of such (*anechinoplacida*); (5) some again have the greater number of the intermediate spines on special local modifications of the integument, which may be known as special plates (*autacanthid*), while "others retain the simpler disposition which is seen in *A. rubens* and most of the better known forms" (*typacanthid*); finally, the spines of the abactinal surface afford modifications of various kinds, some being "simple" (*simplices*), others "rare" (*rarispinosæ*), others "blunt" (*obtusispinosæ*), and still others "acute" (*acutispinosæ*). The possession of one or other of these several characteristics is expressed by symbols, viz:

1 = monacanthid;	2 = diplacanthid;	3 = polyacanthid;
m = monoplocid;	p = polyplacid;	
e = echinoplacid;	a = anechinoplacid;	
a' = autacanthid;	t = typacanthid;	s = simplices;
r = rarispinæ;	r' = retusispinosæ;	c = acutispinosæ.

Further, to distinguish between the Pentactinida and the Heteractinida, Professor Bell proposes "to place the formula for the latter under the mathematical sign of a square root: thus,  $\sqrt{1p}$  is sufficient to distinguish *A. calamaria* as a monacanthid, polyplacid, heteractinid form." By the use of such symbols Professor Bell has given the principal distinctive characters of 78 species within less than an octavo page. The *Asterias vulgaris* of New England, e. g., is diagnosed by the formula, " $\sqrt{2ats}$ , which indicates that it has (1) five rays; (2) is diplacanthid, or with biserial adambulacral spines"; (3) "anechinoplacid," destitute of a circle of spines to the madrepore plate; (4) "typacanthid," or with the intermediate spines simply disposed and not arising from special plates; and (5) with the spines of the abactinal surface simple. (P. Z. S., 1881, pp. 492-515.)

#### BILATERALIA.

##### ENTEROPNEUSTA.

tschnikoff (El.). Ueber die systematische Stellung von *Balanoglossus*. *Zool. Anz.*, 4. Jahrg., pp. 139-143; 153-157.

—. Systematic position of *Balanoglossus*. *Journ. R. Microscop. Soc.*, (2), v. 1, pp. 462-463.

[An abstract of the preceding.]

#### *The systematic position of Balanoglossus.*

The remarkable genus *Balanoglossus* has been re-examined. The earlier naturalists regarded it, in its adult stage, as a worm, and had no suspicion that it could have any other relations. What afterwards

proved to be the larva was, however, with as little doubt, referred to the Echinoderms. In its adult condition it has an internal branchiferous canal, which simulates that of the Tunicates. What, then, are its affinities?

As early as 1870 Metschnikoff considered that it might be really related to the Echinoderms, as its larval condition suggested. This view has not found much favor, but during the past year he reiterated it and fortified it with new arguments, based chiefly on its development.

*Balanoglossus*, then, resembles the Echinoderms in the longitudinal band of cilia, the water-vesicle opening by the dorsal pore, and the peritoneal sacs, while the two hinder circlets of cilia and the terminal anus are developed in some Echinoderms, and the latter is always found in the youngest stages of all typical Echinoderm larvæ. The histological characteristics are equally repeated in the Echinoderms. The course of development is also similar in the two. In short, Metschnikoff insists on retaining *Balanoglossus* with the Echinoderms in the same branch or sub-kingdom—or “type,” as he prefers to call it—and gives to that type the comprehensive name, *Ambulacraria*. *Balanoglossus* is isolated, as a “sub-type” named *Bilateralis*, and the typical Echinoderms form another renamed *Radiata*.

The observations of Metschnikoff have been reviewed by Prof. A. Giard, and supplemented by the French naturalist's own investigations. He calls special attention to the existence, in the *Tornaria* state, of a peculiar heart, which no Echinoderm is known to possess, the comparatively late development of the ciliated circlets, and the presence of a muscular band connecting the dorsal aquiferous system with the median point of the eye-spots—all presenting difficulties in associating *Balanoglossus* with the Echinoderms. Nevertheless, Giard is disposed to coincide with Metschnikoff in approximating the one to the other, while he does not venture to pronounce on the phylogenetic relationships of the two. He even suggests a new argument in favor of the approximation, in the possibility of a similarity of the two in the development alike of excretory and deutoplasmigenous functions, at certain times of the year, of the genital glands. He unqualifiedly repudiates the idea that there is, as has been claimed, any genetic relationship between *Balanoglossus* and the Tunicates. (J. R. M. S., (2,) II, p. 194, from Bull. Sci. Dép. Nord, IV, pp. 372-378.)

## WORMS.

### ORTHONECTIDS.

Metschnikoff (El.). Observations on the Orthonectida. Abstr. in *Journ. R. Microscop. Soc.* (2.) v. 1, pp. 461-462.

#### *Characteristics and relations of the Orthonectids.*

In the notice of the progress of zoology in the Smithsonian Report for 1880, reference was made to the newly proposed “class” of Orthonectida.

The group has been again investigated—this time by Prof. E. Metschnikoff—with the following results:

The Orthonectids may be said to be forms which, on the whole, develop a radiate plan of structure, and have a ciliated and segmented dermal layer, well-developed generative organs, and well-marked dimorphism of the sexes. Professor Metschnikoff considers them to be probably degenerated forms, and suggests that they may be most nearly related to the Turbellarians, through *Dinophilus*, a member of the latter group, which has also a superficial ciliary segmentation and well-marked sexual dimorphism. The sexes are developed from diversiform eggs, the males arising from the smaller eggs and the females from the larger. The males are minute, and their "only evident organ is a spacious testicular sac." The representatives of the "class" move in a straight course, and consequently negative the suggestion of Rabl-Ruckhard, that the radiate plan of structure is due to movement within a restricted area. (J. R. M. S., (2,) I, pp. 461-462, from Z. W. Z., XXXV, pp. 282-304, 1 pl.)

#### PLATYHELMINTHES.

##### 1. General.

Lang (A.). Untersuchungen zur vergleichenden Anatomie und Histologie des Nervensystems der Plathelminthen. *Mittheil. Zool. Station Neapel*, v. 3, pp. 53-96.

———. Der Bau von Gunda segmentata und die Verwandtschaft der Plathelminthen mit Coelenteraten und Hirudineen. *Ibid.*, v. 3, pp. 187-251.

##### 2. Special orders.

###### Cestoda.

Stein (S. Th.). Entwicklungsgeschichte und Parasitismus der menschlichen Cestoden. Mit 79 Illustrat. and 115 microphotogr. Abbild. auf 14 Taf. nach J. Grimm. Lahr, Schauenburg, 1881. (8vo. M. 18.)

###### Trematoda.

Fraipont (J.). Organes excréteurs des Trématodes et Cestodes. *Bull. Soc. Belge. Microscop.*, t. 7, 1881, pp. xxxi-xlii. (Abstr.: *Journ. Roy. Microscop. Soc.*, (2,) v. 1, pp. 741-742.

Pagenstecher (H. Alex.). Zur Entwicklungsgeschichte der Trematoden, insbesondere über Arbeit des Prof. Giambatt. Ercolani: Dell' Adattamento, etc. *Verhandl. nat.-med. Ver. Heidelberg*, n. F., v. 3, pp. 33-56.

###### Turbellaria.

Silliman (W. A.). Sur un nouveau type de Turbellariées. *Compt. rend. Ac. Sc. Paris*, t. 93, pp. 1087-1089.

Selenka (Emil). Zoologische Studien. II. Zur Entwicklungsgeschichte der Seeplanarien. Ein Beitrag zur Keimblätterlehre und Descendenztheorie. Mit 7 Taf. und 2 Holzschn. Leipzig, Engelmann, 1881. (4to. v, 44 pp. M. 6.)

##### *A new suborder of Turbellarians.*

Parasitic on a Nematoid worm—itself parasitic on the Echinoderm, *Echinus sphaera*—occurs a peculiar form, which has been investigated by Mr. W. A. Silliman. The animal is of sublanceolate form, about

225 millimeters long and 1.5 wide, and is destitute of suckers or hooks. Its epidermis is constituted by moderately regular hexagonal and ciliated cells. The male is noteworthy in that it has numerous testicles and the penis ensheathed. The female has a double ovary and pseudovitellogen, and a uterus as well as vagina. The pseudovitellogen is developed in the second third of the body, and is manifested in the form of numerous ramified tubes, which, on each side, unite towards the median line and debouch into the uterus; the vagina opens far back on the dorsal surface and extends forwards toward the uterus. The animal thus distinguished has received the generic name *Syndesmis*. It agrees with the Turbellarians in the ciliated epidermis, oral apparatus, male organs, and the possession of two ovaries by the female, and with the Trematods as to the vagina and disposition of the pseudovitellogen. The peculiar combination of characters is deemed to authorize its erection into a special "sub-order" of Turbellarians. (J. R. M. S., (2), II, pp. 192-193, from C. R., XCI, 1807-1809.)

## NEMATHELMINTHES.

*Nematoda.*

Perroncito (E.). Helminthologische Beobachtungen bezüglich der unter den Arbeitern am St. Gotthard-Tunnel aufgetretenen endemischen Krankheit. In Moleschott's Untersuch. zur Naturlehre d. Menschen, v. 15, pp. 532-562.

## ANNELIDS.

## 1. General.

Kleinenberg (N.). Sull' origine del sistema nervoso centrale degli Annelidi. Relazione del Fr. Todaro. *Atti Accad. Lincei, Transunti*, v. 6, pp. 15-16.

Verrill (A. E.). New England Annelida. Part I. Historical Sketch, with Annotated List of the Species hitherto recorded. *Trans. Connecticut Acad. Sc.*, v. 4, pp. 285-324.

## 2. Special orders.

*Oligochaeta.*

Eisen (Gustaf). Eelipidrilidæ and their Anatomy. A new family of the limicolidæ. *Oligochaeta. N. Acta. R. Soc. Upsaliensis*, 1881. (4to, 10. pp., 2 pl.)

Darwin (Charles). The Formation of Vegetable Mould, through the action of Worms, with observations on their habits. With illustrations. London, J. Murray, 1881. (12mo, vii, 326 pp.)

*Polychæta.*

Rietsch (Max). Organization of *Sternaspis scutata*. *Abstr. Journ. Roy Microscop. Soc.*, (2.) v. 1, pp. 601-602.

Vejdovsky (Frz.). Untersuchungen über die Anatomie, Physiologie und Entwicklung von *Sternaspis*. *Abhandl. Akad. Wiss. Wien*, v. 43.

*A Parasitic Polychætous Worm.*

It is a rule that the Polychæta, the order represented by the great majority of the common marine annelids, lead a free life. It is a rule

which has its exceptions, however, though they are rare. In early life, for example, the Alciopids are parasitic in the ctenophorous cœlenterates, but later become free. But recently Dr. J. W. Sprengel, at Naples, while examining specimens of *Bonellia* (a genus of Gephyrean worms), detected in their cœlom orange-colored cord-like bodies, which manifested lively movements, which proved to be polychætous worms. These were about 10 centimeters long and a millimeter wide, and had about 200 segments; "the maxillary apparatus was rudimentary, and there were only three small teeth in the upper jaw." The form has been named by Dr. Sprengel *Oligognathus Bonelliae*, and referred to the family of Lumbriconereids. An elaborate description has been published, with illustrations. (J. R. M. S. (2,) v. 2, pp. 190, 191.)

#### *Natatory Bladders in Annelids.*

Certain Annelids may be found floating passively on the surface of the water, and one of such species—the *Hesione sicula*—was observed by Dr. H. Eisig to emit air-bubbles both from the mouth and anus. Dr. Eisig sought to ascertain the *rationale* of such phenomena, and his investigations were rewarded by the discovery of a viscus that had apparently been overlooked in the Annelids. In *Hesione* were found two contractile appendages, which communicated with the intestine, and which might be either distinct bladders or inconsiderable diverticula, according to their distension or collapse. These parts are diverticula of the fore stomach, and are regarded as probably arising from the endoderm. Air-bladders were found to be developed in representatives not only of the family Hesionidæ, but also among the Syllidæ, but not universally. Their absence or atrophy, when not developed, has been supposed to be due to the assumption of the function of respiration by the skin; for although the bladders in question serve to float the animal, such office is merely secondary, and not their principal function. Their primary purpose is supposed to be respiratory. They were never found to contain anything except a gas and a clear fluid, which could be taken in or discharged voluntarily by the animal. The so-called air was not atmospheric, and was supposed to be secreted by the stomach, and probably to be oxygen; enough could not be secured to make a chemical analysis. Although, as already remarked, the organ with its functions has previously been unnoticed, it was known—*e. g.*, in the Syllidæ—as the "T-shaped glands."

#### *Worms as Earthmakers.*

The common earth-worm comes within the cognizance of the ordinary observer chiefly as a useful bait to be impaled on a hook and thus used for attracting fish for the sport of the angler. The juvenile representatives of the brotherhood of the rod have generally learned to recognize

the whereabouts of their victim by conglomerations of little pellets of earth here and there; and knowing ones are wont to cautiously explore localities so indicated with lanterns at night or in the early morning, and there find the worms partly or entirely outside their holes. Few of the many who have learned thus much of the animal in question have ever thought of the important functions in the economy of nature performed by the humble being. Even as far back as 1837, however, Mr. Darwin had appreciated the rôle that it plays and communicated to the Geological Society of London a special memoir "On the Formation of Mould" by worms. Considerable skepticism was evoked respecting his conclusions, so insignificant did the means appear to the end, but the author published as his last contribution to science a special work on the subject, and has fortified and amplified his early studies and conclusions. As Darwin says, some observant "farmers are aware that objects of all kinds left on the surface of pasture land after a time disappear, or, as they say, work themselves downward." This disappearance is of course due to no automatic process of the objects sinking down, but really to the cumulative effect of worms' castings. The doubt such a statement may excite will be dissipated by a knowledge of what a worm can do in a given period, and the multiplication of that amount by number and time.

Hensen, in experiments made on worms in confinement and fed on leaves, found that they ejected about eight grains of earth a day; but, according to Darwin, "a very much larger amount must be ejected by worms in their natural state, at the periods when they consume earth as food instead of leaves, and when they are making deep burrows." In corroboration of this opinion, Darwin has tabulated the results of numerous observations on the "weight of the castings accumulated at the mouth of a single burrow." Before weighing, the castings were dried (excepting in one specified instance) by exposure during many days to the sun or before a hot fire." These castings for each hole "generally exceeded an ounce in weight after being dried, and sometimes nearly equaled a quarter of a pound. On the Nilgiri Mountains one casting even exceeded this latter weight. The largest castings in England were found on extremely poor pasture land; and these are generally larger than those on land producing a rich vegetation. It would appear that worms have to swallow a greater amount of earth on poor than on rich land, in order to obtain sufficient nutriment." (P. 162.) In another place we are told that Hensen found that "there must exist 133,000 living worms in a hectare of land, or 53,767 in an acre. This latter number of worms would weigh 356 pounds, taking Hensen's standard of the weight of a single worm, namely, one gram. It should, however, be noted, says Mr. Darwin, "that this calculation is founded on the numbers found in a garden, and Hensen believes that worms are twice as numerous in gardens as in cornfields." On the

other hand, recent observations demonstrate that worms may occur in even much greater numbers than were found by Hensen. An English gentleman, *e. g.*, found in Hertfordshire, "in his forest land, as many as 100 to the cubic yard, and in a rich strip bordering vines not less than 180 animals in an equal area; *i. e.*, from 484,000 to 871,000 to an acre." (Critic, N. Y., v. 2, p. 76, 1881.)

A little calculation will convince the most skeptical that worms with the habits thus indicated and in the numbers known to occur must in time produce great effects. Mr. Darwin has been observing their habits and doings for many years. "Near Maer Hall, in Staffordshire, quicklime had been spread, about the year 1827, thickly over a field of good pasture-land which had not since been plowed. Some square holes were dug in this field in the beginning of October, 1837; and the sections showed a layer of turf formed by the matted roots of the grasses, half an inch in thickness, beneath which, at a depth of  $2\frac{1}{2}$  inches (or 3 inches from the surface), a layer of the lime in powder or in small lumps could be distinctly seen running all round the vertical sides of the holes." (P. 130.) Again, a quantity of broken chalk was spread on December 20, 1842, over part of a field near Darwin's house. "The chalk was laid on the land for the sake of observing at some future period to what depth it would become buried. At the end of November, 1871—that is, after an interval of 29 years—a trench was dug across this part of the field, and a line of white nodules could be traced at a depth of 7 inches from the surface. The mold, therefore (exclusive of the turf), had been thrown up at an average rate of .22 inch per year." (P. 139.) In view of such operations we can readily account for the burial of ancient cities and towns, and a number of cases in point are cited in a special chapter on "the part which worms have played in the burial of ancient buildings." The subsidence of pavements, the burial of Roman villas at Abinger, Chedworth, Brading, and elsewhere, the entombment of the Roman towns of Silchester, Wroxeter, &c., are shown to be mainly due to the action of worms. We can readily comprehend, therefore, how it is that the more ancient cities which once flourished in Asia and the older seats of civilization have been covered to such a depth as to have been entirely concealed, even without taking into consideration the accumulation of dust and other dirt.

Analyses of worm-casts have been communicated to the Royal Horticultural Society, by Dr. Gilbert, with reference to the amount of nitrogen involved. He found that the dried mold contained 35 per cent. of nitrogen, which was considerably more than was present in the mold of pasture land and two or three times more than in that of arable land. It was less rich, however, than highly manured kitchen-garden mold. On the whole the soil only gained from what the worms brought up from below, as by trenching.

## ARTHROPODS.

## MEROSTOMES.

*Trilobita.*

Ford (S. W.). Embryonic Forms of Trilobites from the Primordial Rocks of Troy, N.

Y. *Am. Journ. Sc.*, (3,) v. 22, p. 250-259.

Walcott (C. D.). The Trilobite: New and Old Evidence relating to its Organization.

*Bull. Mus. Comp. Zool.*, v. 8, p. 191-230, with 6 pl.

*Xiphosura.*

Jousset de Bellesme. Observations sur les fonctions de l'appendice caudal des Limules.

*Ann. Scienc. Nat.* (6), v. 2, Art. No. 7. (5 p.)

Lankester (E. Ray). *Limulus* an Arachnid. *Quart. Journ. Mic. Sc.*, n. s., v. 21, pp.

504-548, 609-649, pl. 28-29, July and Oct., 1881.

*Relations of the Merostomes.*

The Merostomes, *i. e.*, the Horseshoe Crabs of the present epoch and their ancient relatives, as well as the Trilobites, have been almost universally considered, until within the last few years, as true Crustaceans. As long ago as 1829, however, an eminent French anatomist—Straus Durkheim—maintained that *Limulus* belonged rather to the Arachnids, and was the type, in that class, of a peculiar order, which he named "Gnathopodes." The Arachnids, for him, were characterized by the legs abutting on a common sternum, the presence of an internal cartilaginous sternum, and the absence of antennæ. Alphonse Milne-Edwards proposed to isolate the group as an intermediate form between the Crustaceans and Arachnids. Claus and Packard considered the group to be one of primary importance within the Crustaceans, the Horseshoe Crab and its allies representing a subclass in contrast with all the other representatives of the class.

Prof. E. Ray Lankester has recently discussed the gross morphology and relationships of these most gigantic of articulates in the Quarterly Journal of Microscopical Science, and presented quite a complete and well-digested analysis of their characters compared and contrasted with those of Arachnids and Crustaceans. A detailed comparison is instituted between *Limulus* and *Scorpio*, segment for segment, and the results thereof are summarized in very convenient form, in tables, for *Limulus* on one page, and *Scorpio* on the opposite, exhibiting in several columns the characteristics of the segments from the first to the eighteenth, as to (1) the Tergites, (2) the Sternites, and (3) the Appendages. The differences between the forms thus specially compared are great in some respects, although generally less than those which would be apparent on a comparison between *Limulus* and any true Crustacean. The hiatus intervening between the two is, however, to a considerable extent bridged over by the Eurypterina of the Palæozoic epoch. Inasmuch as the close affinity of the Eurypterina to the Limulids is now universally admitted, that which is relevant to the former is applicable to the



major group of which both are equally members. Professor Lankester is therefore fully justified in the postulate that "there is not only a general resemblance of the Eurypterine body to that of the Scorpion, but that in many of the most important points the Eurypterine body and appendages agree precisely with those of the Scorpion, and not in a merely general way. The Eurypterina, in fact, confirm the validity of the comparisons between *Limulus* and Scorpion.

Finally, Professor Lankester has summed up the points of agreement of the Horseshoe Crab and Eurypterids with the Arachnids, and their differences from the Crustaceans, in the following terms:

1. *Limulus* and the Eurypterines (the one supplementing the other) agree precisely with the Scorpion in the existence of eighteen segments expressed in the structure of their bodies, and in the distribution of these segments into three groups of six each, viz: a leg-bearing cephalothoracic region; an anterior abdominal region, in which each segment carries lamellate appendages; and a posterior abdominal region devoid of appendages, ending with the anus and a postanal spine. No Crustacean presents this number and grouping of its constituent somites.

2. *Limulus* and the Eurypterines agree with the Scorpion precisely in the position of the genital aperture beneath an opercular plate formed by the coalescence of the seventh pair (in Eurypterines the actual sixth pair of appendages). No Crustacean has the generative orifice so far forward, and in none is there a genital operculum of the kind having such relations of position to the general apertures.

3. They agree with the Scorpion in the character and position of the mouth and upper lip.

4. They agree with the Scorpion in possessing a metathoracic sternite, in the possession of a fibro-cartilaginous entosternite, and in the precise form and relations of that organ. No Crustacean possesses an entosternite or any structure resembling it.

5. They agree with the Scorpion in the disposition of central (single) and lateral (grouped) eyes on the cephalothorax. No Crustacean has an identical arrangement of single and grouped eyes.

6. *Limulus* agrees with the Scorpion in the form of the alimentary canal and its lateral outgrowths (liver), which are more than one pair. In Crustacea it is very exceptional to find more than one pair of such diverticula, though a single pair may carry numerous secondary branches.

7. It agrees with the Scorpion in possessing a supra- or circum-medullary (spinal) artery, which arises from the dorsal aorta by two arches embracing the œsophagus. No Crustacean has such a supra-spinal artery so originating.

8. It agrees with the Scorpion in the form of the generative glands. No Crustacean has its generative glands in the form of an anastomosing network.

9. It agrees with Scorpio in possessing vibratile spermatozoa. No Crustacea, except Cirrhipedia, are known to have vibratile spermatozoa.

10. It agrees with Scorpio and Spiders in having a brain which (like that of that embryo Scorpion and Spider) supplies only eyes and integument with nerves, and not any appendage. In all Crustacea, except some Phyllopoda, such an archicerebrum does not exist; but even in young stages the brain is found to supply at least one pair of appendages, as well as the eyes.

11. It agrees with Scorpio in the concentration of the origins of nerves supplying the anterior part of the abdomen, in the cephalothorax, in the form of a nervous collar, perforated by the pharynx. Such a nerve-collar has its parallel in Crustacea, among the brachyurous Decapoda, which, however, are in other respects the Crustaceans which least resemble *Limulus*.

The points in which *Limulus* agrees with the Crustacea and differs from Arachnida are three only. They are as follows:

1. *Limulus* agrees with many Crustacea, and differs from Arachnida, in that its respiratory organs are adapted to an aquatic in place of an aërial medium.

2. *Limulus* agrees with Crustacea, and differs from Arachnida, in that it possesses a pair of groups of eyes, in which the association of the individual eyes of each group is so close as to constitute a compound eye.

3. *Limulus* agrees with Crustacea (excepting some Isopoda?), and differs from Arachnida, in *not* possessing glandular cœca (the Malpighian tubules) growing out from the proctodæum.

In conclusion, Professor Lankester referred the Merostomes unreservedly to the class of Arachnids, and divided that class into three subclasses, or "grades," the first of which he calls Hæmatobranchia—a new name for the Merostomes—and the other two of which are designated Aerobranchia (Scorpionina, Pedipalpi, and Araneina) and Lipobranchia (Solifugæ, Pseudoscorpionina, Opilionina, and Acarina). Among the Hæmatobranchia he recognizes three "orders," viz:—Trilobita, Eurypterina, and Xiphosura.

### *Legs of Trilobites.*

The Trilobites have long been favorite objects for the collector of fossils, occur in exuberant abundance in many rocks, are very often found in fine condition—so far at least as the dorsal portion is concerned—and have been the subjects of several thoughtful monographs. Nevertheless, Professor Huxley, in 1877, gave expression to the current belief respecting them when he wrote (*Anat. Invert. An.*, p. 258) that "up to [that] time, no certain indications of the existence of appendages, nor even of any hard sternal body-wall, [had] been discovered, though a shield-shaped labrum, which lies in front of the mouth, has been preserved in some specimens." But in that same year, 1877, Mr. C. D.

Walcott completed the proof of the existence of true legs in Trilobites of the genera *Calymene* and *Oeraurus*. Thus, too, the correctness of an observation made about six years before (in 1870) was confirmed, for Mr. E. Billings, the palæontologist of Canada, then announced the discovery of traces of legs. The accuracy or relevancy of his observations was generally denied, however, and certainly they needed confirmation. Mr. Walcott, continuing his studies, in 1881 published the results of his researches in a memoir on "The Trilobite; new and old evidence relating to its organization." He has done his work well, and by means of numerous sections, longitudinal as well as transverse, has traced the course and structure of the appendages, and at least conclusively established the existence of legs homologous with those of the King crab and Eurypterids. But he further claims that such appendages were repeated on each segment, and that in addition to the homologues of the five pairs of legs whose basal joints perform the office of manducation, there are "numerous thoracico-abdominal appendages." If this statement is the true expression of the facts, it is evident that while the relations of the Trilobites with the typical Merostomes are established, the type of structure is in the highest degree peculiar. So remarkable would be the deviation from the standard that probably many may feel disposed to await further evidence and suspend opinion, lest the observed facts may be susceptible of some other interpretation. That which will probably provoke most skepticism is the attribute to the pygidium of plural pairs of limbs similar to the others, and indeed Mr. Walcott himself admits that as to the character of those appendages "the evidence is not all that could be desired" (p. 204). On the other hand, it may be added that the well-known variability, according to group as well as to individuals, of the number of segments prepares us to expect, or at least not to be unduly surprised at, some remarkable deviation from the typical mode of segmentation and appendicular apparatus. We may, therefore, concede that the limbs are existent in increased number, but must hold in abeyance confession of belief in their extension as such, and unmodified, to the extreme end of the pygidium.

The facts being admitted, even with reservation as to details, little fault can be found with Mr. Walcott's systematic conclusions. He recognizes as constituents of a peculiar "class," under the name "Pœcilopoda," the typical "Merostomata" (of which he makes a sub-class with two "orders"—the Xiphosura and Eurypteridæ) and the Trilobites, which, at the same time, represent a "sub-class Palæadæ" and an "order Trilobita." He formulates the results of his comparative researches on the structure of the last in his diagnosis of the "sub-class" as "Pœcilopods, with numerous thoracico-abdominal appendages, eyes compound (when developed), ocelli unknown," while the "order" is distinguished by a "mouth furnished with a large hypostoma and four pairs (as far as known) of appendages; thoracic segments, 2—26, bear-

ing pointed legs with attached branchiæ; abdomen formed of anchylosed segments, 2(†)—28, bearing articulated appendages."

The memoir of Mr. Walcott is illustrated by 6 plates, displaying sections and other details of structure. The author's discoveries certainly mark an epoch in the history of the Tribolites.

## CRUSTACEANS.

## 1. SYSTEMATIC.

Kossmann (R.). Ueber den classificatorischen Werth der Mundorgane der Crustaceen. *Zool. Anz.*, 4. Jahrg., pp. 544-548.

## 2. FAUNÆ.

*Europe.*

Meinert (Fr.). Crustacea Isopoda, Amphipoda et Decapoda Daniæ; Fortegnelse over Danmarks Isopode, Amphipode og Decapode Krebsdyr. *Naturhist. Tidsskr.*, (3,) v. 12, pp. 465-512.

*North America.*

Smith (S. J.). Preliminary Notice of the Crustacea dredged in 64 to 325 fathoms, off the south coast of New England, by the United States Fish Commission in 1880. *Proc. U. S. Nat. Mus.*, v. 3, pp. 413-452.

*Middle America.*

Edwards (Alphonse Milne). Mission scientifique au Mexique et dans l'Amérique centrale. Recherches zoologiques publiées sous la direction de H. Milne-Edwards. 5. partie t. 1. Études sur les Xiphosures et les Crustacés podophthalmes; par Alph. Milne-Edwards. Paris, Impr. nationale, 1881. (4to., 372 pp., 61 pl.)

*Caribbean deep-sea fauna.*

Edwards (Alphonse Milne). Considérations générales sur la faune carcinologique des grandes profondeurs de la mer des Antilles et du Golfe de Mexique. *Compt. rend. Acad. Sc.*, Paris, t. 92, pp. 384-388.

———. General considerations upon the Carcinological Fauna of great depths in the Caribbean Sea and Gulf of Mexico. *Ann. Mag. of Nat. Hist.*, (5,) v. 7, pp. 312-317.

———. Report of the results of Dredging in the Gulf of Mexico. Part I. Études préliminaires sur les Crustacés. *Bull. Mus. Compar. Zool.*, v. 8, No. 1.

## 3. SPECIAL GROUPS.

*Pycnogonida.*

Wilson (Edmund B.). Report on the Pycnogonida of New England and adjacent waters. *Report U. S. Fish Commission for 1878*, pp. 463-506, 7 pl. (15 sp., of which 2 are new.)

*Copepoda.*

Grobbe (C.). Die Entwicklungsgeschichte von *Cetochilus septentrionalis* Goods. *Arb. Zool. Instit. Wien*, v. 13, p. 243-282.

*Branchiopoda.*

Lankester (E. Ray). Observations and Reflections on the Appendages and on the Nervous Systems of *Apus canceriformis*. *Quart. Journ. Micr. Sc.*, v. 21, pp. 343-376, 1 pl.

*Edriophthalma.*

Delage (Yves). Contributions à l'étude de l'appareil circulatoire des Crustacés Edriophthalmes marins. *Arch. Zool. Expériment.*, t. 9, pp. 1-144.

*E. Amphipoda.*

Ulianin (B.). Zur Entwicklungsgeschichte der Amphipoden. *Zeitschr. f. wiss. Zool.*, v. 35, pp. 440-460.

*E. Isopoda.*

Harger (Oscar). Report on the Marine Isopoda of New England and adjacent waters. *Report U. S. Fish Commission for 1878*, pp. 297-462, 12 pl.

Kossmann (R.). Studien über Bopyriden. I. Gigantione Moebii und Allgemeines über die Mundwerkzeuge der Bopyriden. II. Bopyrina Virbii, Beiträge zur Kenntniss der Anatomie und Metamorphose der Bopyriden. *Zeitschr. f. wiss. Zool.*, v. 35, pp. 652-680.

Miers (Edw. J.). Revision of the Idoteidæ, a family of sessile-eyed Crustacea. *Journ. Linn. Soc. London, Zool.*, v. 18, pp. 1-88, pl. 1-3.

*Decapoda.*

Edwards (Alphonse Milne). Description de quelques Crustacés macroures provenant des grandes profondeurs de la mer des Antilles. (Suite.) *Ann. Scienc. Nat.*, (6), *Zool.*, v. 11. (16 pp.)

Packard (A. S., jr.). On a Cray-fish (*Cambarus primævus*) from the lower Tertiary beds of Western Wyoming. *Bull. U. S. Geogr. and Geolog. Surv. Territ.*, v. 6, pp. 391-397.

*Deep-sea Crustaceans.*

One of the most interesting as well as important results of the deep-sea investigations in recent years has been the discovery of the richness of the Crustacean fauna at great depths. The Decapods obtained by the United States Coast-Survey ship Blake in the Caribbean Sea and Gulf of Mexico have been reported on by Prof. A. Milne Edwards, of Paris, and the revelations have been most interesting as well as unexpected. At those depths which were regarded by naturalists of the past generation as devoid of life, numerous remarkable forms, previously wholly unknown, were discovered. The brachyurans—true crabs—occur but sparingly at great depths, but even of them species extend downward as low as 400 fathoms, in which zone a form allied to the genus *Gonoplax* is represented. It is blind, and has been named by Mr. Edwards, *Bathyplox*. But it is the Anomurous and Macrurous Decapods that are especially abundant in the deep sea. Of the family of Paguridæ—hermit crabs—numerous forms were secured which are interesting not only in themselves, but on account of the light they cast on the morphology of the group, and the “intermediate” types they furnish. One, for example—*Pylocheles Agassizii*—has a regularly annulated abdomen terminated by a symmetrical fin instead of the usual soft “tail,” and thus recalls the Thalassinidæ. Others, on the contrary—*Spiropagurus* and *Catapagurus*—have very small and sub-spiral abdo-

mens, which they insert in correspondingly small spiral shells. Other remarkable modifications are exemplified in various new genera, designated as *Mixtopagurus*, *Ostraconotus*, *Xylopagurus*, &c. Again, the family of the Galatheidæ, which was previously not known to be represented in American waters, furnished 41 species, representing a number of new genera, as well as the widely distributed old genera, *Galathea* and *Munida*, the latter of which was increased by the addition of 11 new species. Species of the family extend downward to the depth of 2,000 fathoms or more. Finally, the family of Dromiidæ is now ascertained to be characteristic of the deep and rich in species, and the family of Eryontidæ is confirmed as an equally characteristic deep-sea type. Reduction or complete atrophy of the eyes was a common attribute of the newly discovered species, but by no means universal. A species of *Munida*, on the contrary, was marked by an excessive development of the eyes. They are thus analogous in this respect, as a whole, to the deep-sea fishes.

*Deep-sea Crustaceans near the New England coast.*

The deep equatorial seas are not singular. While such rich accessions have been made to the class of Crustaceans from the deep Caribbean and Gulf seas, additions of no inconsiderable importance have also accrued from the exploration of the ocean farther north. Under the auspices of the United States Fish Commission, in 1880, the steamer Fish Hawk made three dredging trips to the "Block Island soundings," off the eastern end of Long Island, between latitude 39° 46' and 40° 06' N., and longitude 70° 22' and 71° 10' W. The depths explored varied from 64 to 500 fathoms. The Crustaceans obtained on these trips were studied by Prof. Sydney I. Smith. Professor Smith remarks that "the richness, in both species and individuals, of this Crustacean fauna would never have been suspected, and scarcely dreamed of, by one accustomed only to the meagre fauna of the shallower waters of the south coast of New England. The larger part of the species secured from the great masses of material brought up in the trawl and dredge are Decapoda." There are comparatively few small species of Schizopoda, Cumacea and Amphipoda, and further dredging will undoubtedly increase very greatly the number of species in those groups. Premising that the "enumeration is not complete even for the Decapoda," Professor Smith enumerates just 50 species, of which some are widely diffused, although 43 of them are for the first time recorded "as belonging to the New England fauna south of Cape Cod"; 14 are described as new, and 3 others are indicated as partially new, while one new generic type was discovered—*Hemipagurus*, with two species—belonging to the family Paguridæ, so much enlarged by Prof. A. Milne Edwards. Thirty-two of the species were Decapoda; the others were Schizopoda (4), Cumacea (1), Stomatopoda (1), Amphipoda (7), and Isopoda (5).

*Parasitic Crustaceans.*

The extent to which fishes of various kinds are infested with Crustacean parasites is little known. A considerable proportion will yield parasites to the careful searcher. Mr. A. Valle has examined a large number of Adriatic fishes, and found 69 species of entomostracans alone. Out of 670 fishes examined, as many as 250 had entomostracan parasites. A new species of the remarkable genus *Philichthys*, named *P. Richiardi*, was discovered in the canal of the preopercular bone of the sparoid fish known as *Box salpa*.—(Bull. Soc. Adriat. Sc. Nat., vi, pp. 55–81.)

*A fossil Tertiary Cray-fish.*

The fresh-water cray-fishes of the family Astacidæ and like animals are of new interest since the publication of Professor Huxley's monograph on the cray-fish; and in view of the peculiarities of their distribution. The representatives of the family inhabiting the waters of the northern hemisphere are divided into genera variously distributed. They resemble each other closely externally, but are distinguished especially by the number of the gills. The typical species constitute the genus *Astacus*, which is developed in the Old World, and also on the Pacific slope of North America, while the species of the eastern waters of North America belong to a peculiar genus, named *Cambarus*. These types are of considerable antiquity, and Professor Packard has discovered in the lower Tertiary shales of Western Wyoming, which are supposed to be of the Eocene age, remains which he refers to the limited genus *Cambarus*, with the name *Cambarus primævus*. The species, in his own words, "is exceedingly interesting, from the fact that it represents a period in which heretofore no fossil cray-fish has been found. The soft, fine, fossil, clayey shales of the Bear River Tertiaries contain not only a good many herring-like fish, but also genuine skates. The presence of land plants, mingled with marine animals, shows that the waters were fresh, but communicated with the sea. The conditions were apparently those of a deep estuary into which fresh-water streams ran, and in these rivers lived the cray-fish."

It is claimed that "the discovery of an apparently fresh-water *Cambarus* in the Green River beds of Northern Wyoming, which are supposed to be lower Eocene strata, fills up a break in the geological series hitherto existing between the Cretaceous and Pliocene cray-fishes, and shows that the dynasty of fresh-water cray-fish, now so powerfully developed in the United States, began its reign during the early Tertiary period."

## ARACHNIDS.

## 1. FAUNÆ.

*Europe.*

Simon (Eug.). Les Arachnides de France. t. 5. 1. partie, contenant les familles des Epeiridæ (supplément) et des Theridionidæ (commencement). Paris, Roret, 1881. 8vo. (186 pp., 1 pl.)

*Asia.*

Phorell (T.). Stud sui Ragni Malesi e Papuan. III. Ragni dell' Austro-Malesia e del Capo York, osservati nel Museo Civico di Storia Naturale di Genova. *Ann. Mus. Civ. Stor. Nat. Genova*, v. 17, pp. vii-xxvii, 1-720.

NOTE.—I and II were published in *Ann. Mus. Civ. St. Nat.*, v. 10 and 13.

*Australia.*

Koch (L.). Die Arachniden Australiens nach der Natur beschrieben und abgebildet. Fortgesetzt von Graf E. Keyserling. 28. Lief. Nürnberg, Bauer & Raspe, 1881. (4to. M. 9.)

## 2. SPECIAL GROUPS.

*Acarina.*

Haller (G.). Vorläufige Bemerkungen über das Gehörorgan der Ixodiden. Mit Abbild. *Zoolog. Anz.*, 4. Jahrg., pp. 165-167.

———. Die Mundtheile und systematische Stellung der Milben. *Zool. Anz.*, 4. Jahrg., pp. 380-386.

*Tardigrada.*

Jung (—). Ueber Tardigraden. *Zeitschr. f. d. ges. Naturwiss.*, v. 54, pp. 190-192.

———. Revival of Tardigrades after Desiccation. *Journ. R. Microscop. Soc.*, (2,) v. 1, p. 5, Oct., p. 732.

Abstract of preceding.

*Araneida.*

Karsch (F.). Eine neue Vogelspinne aus Südafrika (*Stromatopelma*—n. g.—*alicipillatum*—n. sp.). *Berlin. Entomolog. Zeitschr.*, v. 25, pp. 217-218.

MacCook (H. C.). How Orb-Weaving Spiders make the Framework or Foundations of Webs. *Proc. Acad. Nat. Sc. Phila.*, 1881, pp. 430-435.

Simon (E.). Révision de la famille des Sparassidæ (Arachnides). *Act. Soc. Linn. Bordeaux*, v. 34, pp. 223-351, 1880.

*The relations of the Mites.*

The small animals known as Mites have been usually regarded as representatives of the class of Arachnids. Dr. G. Haller, however, has lately studied these forms with great care, and finds that they have not only three pairs of maxillæ and a true labium, with palpi, but two pairs of abdominal, besides the cephalothoracic legs. He considers, therefore, that they do not belong to the Arachnids, and that they are even more nearly allied to the Crustaceans, from which they chiefly differ in breathing through tracheæ instead of gills. On account of this peculiar combination of characters he proposes that they should form a class of Arthropods, collateral to the Crustaceans, Arachnids, and Myriapods and Hexapod insects.

*Two remarkable Spiders.*

A most peculiar Spider, inhabiting the Island of Madagascar, has been made known by the Rev. O. P. Cambridge. The cephalothorax, instead of being simply convex or little tuberculated, as usual, is extraordinarily developed. It first (1) rises upward, like a long, attenuated



neck, and then (2) swells backwards, as well as forwards, into a head-like prominence, which (3) presents an anterior and downward surface for the falces, near which are the largest eyes; (4) the falces are elongated to correspond with the development of the cephalothorax and curved. In brief, when viewed from the side the cephalothorax and falces combined forcibly remind one of an *Ibis*, or, still more, a *Balaniceps* in a state of rest, with the head inclining backward, the cephalothorax representing the neck and head, and the falces the bill. The mimicry, or rather resemblance, is even stronger in this instance than that of a horse's neck and head by the anterior portion of the Sea-horse, or *Hippocampus*. The abdomen is higher than long, and rises upward in a conic prominence. This spider is of rather small size, and has been described from a single immature male specimen. It has been named *Eriauchenus Workmanni*. Mr. Cambridge has provisionally referred it to the family Theridiidae, and would put it "in a separate group, near the genera *Argyrodes*, Latr., and *Ariamnes*, Thor.," but thinks that "very probably the future discovery of other allied species will necessitate the formation of a new family for them." (P. Z. S., London, 1881, pp. 767-770, pl. 66, fig. 2 a-f.) The aberration of the form from its nearest relatives, indeed, appears to be sufficient, involving as it must corresponding structural modifications, to justify its differentiation as a family type without waiting for kindred species. One of the prime objects of taxonomy should be to express in the system and nomenclature the facts of structure, without reference to the number of species under which peculiarities are manifested.

Another singular Spider, unlike an ordinary spider as a spider could well be, has been made known by Mr. Cambridge, under the name *Ariamnes attenuata*. It is an inhabitant of Brazil ("the Amazons"). If motionless on the ground it might be mistaken for a thorn or small dirt-covered pin. The cephalothorax is oblong, and with the oculiferous area elevated into a slight conical eminence. The abdomen presents an extraordinary development, being subcylindrical, very long, and attenuated to an acute point, almost as much as the shaft of an ordinary pin. The legs are very unequal in length, the first being longest, and the fourth, second, and third pairs successively shortened; the third pair are much the shortest. In fine, the animal looks at first sight much more like an elongated orthopterous insect than a spider. As already intimated, the genus *Ariamnes* has been associated with *Eriauchenus* in the same artificial family—Theridiidae.

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*Peculiar carboniferous Myriapods.*

In 1868, Messrs. Meek and Worthen described a peculiar spinigerous Myriapod, found in ironstone nodules, occurring in the Carboniferous formation of Illinois, under the name *Euphoberia major*. They referred it to the order of Myriapods, but the condition of their specimens did not enable them to satisfactorily elucidate its structure. Later, better preserved specimens for that purpose were secured, and have been studied by Mr. S. H. Scudder. Some noteworthy peculiarities of structure were disclosed, which contrast with those of living Myriapods. In the segments of the body "the dorsal plate occupies scarcely more than two-thirds of the circuit of the body, or even less," and is opposed by a broad ventral plate; the dorsal plate is "not perforated for foramina repugnatoria, but, as means of defense, it is armed with two or three huge spines upon either side"; the ventral plates "occupy the entire ventral surface," or may even extend upwards; they are together equal in length to any part of the dorsal plate, the segments of the body being equal in length throughout. The legs, "instead of being inserted at the extreme posterior edge of the plate, are planted almost in its very center, are appreciably distant from their opposites, and are comparatively large; they also differ from those of modern types in having the second joint as long as the others combined." The stigmata are large and "situated in the middle of each ventral plate." Between the coxal cavities are peculiar paired organs, "situated one on either side of the median line at the very front edge of every ventral plate," thought by Mr. Scudder to be "supports for branchiæ." On account of such peculiar characters or their combination, Mr. Scudder is of the opinion that the *Euphoberiidae* should be placed "in a group apart from" the primary subdivisions recognized for living Myriapods, and has proposed to isolate them in a division co-ordinate with the Diplopoda and Chilopoda, which he has named *Archipolypoda*. (A. J. S. (3), xxi, 182-186.)

*The Blood of Insects.*

The characteristics of the blood of insects have been investigated by M. L. Frédéricq, of Belgium, as manifested in the larva of *Oryctes nasicornis*, a lamellicorn beetle. Blood drawn from the dorsal vessel by a glass cannula was a colorless fluid having nearly the same appearance as the lymph of mammals, but numerous colorless globules diffused through the fluid negatived complete transparency. Coagulation supervened immediately, and the fluid turned to a dark-brown color soon after exposure. This change was due to oxidation, and not at all to light. The coloration is not related to respiration. In reality the phenomenon of change is one of death, and may be compared to spontaneous coagulation. There is no evidence of the existence of either hæmoglobin or hæmocyanin in the blood.

*Stigmata of Insects.*

The respiratory system of the hexapod insects has been examined by Dr. O. Krancher as to a large number of species. The variation of the stigmata in structure as well as other characteristics proved to be very extensive, and consequently no positive generalizations could be formulated. The principal conclusion was that the variations were correlated with adaptation for various modes of life. The method of investigation adopted by the author is detailed in his memoir. (J. R. M. S., I, 729, from Z. w. Z., v. xxxv, pp. 505-574.)

In this connection it may be added that Dr. H. Hagen, in opposition to the views of Dr. Palmén, contends that the stigmatic cords are not rudimentary and closed tubes, but functionless open ones, and that they do not become completely developed during the larval stages. (Z. A., iv, 404).

Dr. O. Krancher, in 1880 (Zool. Anz., v. 3, pp. 584-588), had grouped the modifications of the stigmata known to him into two primary groups and five secondary ones; those without lips having been referred to two categories, and those with lips to three.

*An Insectarium.*

In the year 1881 the Zoölogical Society of London added to its rich exhibition a new feature in the shape of an insectarium. No previous attempt, at least on an extended scale, had been made to bring together a collection of living insects for popular instruction, and the novel addition therefore deserves some notice. The insectarium is housed in a building framed of iron and glass on three of its sides, while its back is brick; the structure, however, was not expressly erected for the use to which it has been put, and its interior arrangements need only be considered. The insects are imprisoned in special cases, the largest of which are 32 inches long and 24 wide, with a depth of 18. Those used for the principal specimens are formed of zinc plates. The upper part of each is glazed on all four sides, the top being

formed of perforated zinc so as to admit the air. The food-plant or object required for the suspension of the chrysalis, when that stage of the insect is exhibited, is inserted into the case through a circular hole in the bottom; but the glass front also opens, so that ready access may be obtained to the interior. The cases are arranged all along the sides of the interior of the building as well as on two tables in the middle. The contents of the several cases are indicated by labels and supplemented by mounted specimens of the corresponding species in its various stages of development. The most conspicuous of the exhibits are the large *Bombycidae*, or silk-producing moths, which had been obtained from their respective habitats in the chrysalis form; among them were the American *Samia cecropia* and *Samia Gloveri*, and it was found that the former selected the plum-tree and the latter the gooseberry as favorite food-plants.

*The Periodical Cicada, alias "Seventeen-year Locust."*

The well-known Cicada, which, from its periodical appearance, has been designated as "The Seventeen-year Locust," is represented by a form, which, according to entomologists, cannot be specifically differentiated from it, but which differs in habits, appearing at intervals of only thirteen years, and which has consequently been designated by Professor Riley as the *Cicada tredecim*. Certain broods of both of these forms coincided in their appearance in 1881: one of *septemdecim* had made its last appearance in numbers in the year 1864, and one of *tredecim* in 1868, and the last simultaneous appearance of the two would therefore have been in 1660.

*Alternate generation in the Gall Insects.*

In certain species of Cynipidæ Dr. Adler has discovered that alternation of generation takes place, and that the same species in the two stages may show such differences that the respective forms had been previously referred to two distinct genera. The discovery was made through the observation that *Neuroterus* laid eggs which gave birth to a form representing the genus *Spatheogaster*, such form being an agamic condition. The organs of generation are nevertheless reproduced in the agamic offspring, and the eggs are even developed generally in larger number. It is noteworthy, also, that in the agamic form there is also a receptaculum seminis, but it is rudimentary: 19 species representing three genera—*Neuroterus*, *Dryophanta*, and *Biorhiza*—manifest alternation of generation, but four others, of the genus *Aphilothrix*, do not develop the agamic stage. These results are confirmatory of deductions by Bassett and Riley made in the United States about ten years ago.

*Peculiar glands connected with the Bee's Tongue.*

The common honey bee was being examined as to the structure of its "tongue" by Mr. Justin Spaulding, when he discovered in the mentum

a small spiral tube, and traced it to a glandular body which he considered to have been previously overlooked. A full description has been given, but it can be only stated here that Mr. Spaulding believes that these glands, on account of their size, position, and outlet, furnish the secretion which changes the nectar into honey. As to their homologies, he suggests that they are the spinning glands of the larvæ modified for the new function, and that in such cases they should be found more or less developed or aborted in other Hymenoptera.

#### *Aquatic Lepidopterous Larvæ.*

The butterflies and especially their caterpillars are so associated in our minds with terrestrial vegetation, that few conceive of the existence of forms that spend their entire larval condition in the water, and that are especially adapted for aquatic respiration. Yet M. C. Maurice has indicated that most of the prominent groups of the Lepidoptera have aquatic representatives. Members of the families Bombycidæ and Sphingidæ live during their caterpillar stage in the waters, but none are known to have tracheal gills. The larva of *Paraponyx*, a form of the family Pyralidæ, however, has long been known to be provided with branchiæ as well as spiracles, and its pupa to live in its cocoon among leaves under water. The structure of that type has been re-examined by M. Maurice so far as its respiratory functions are concerned. The tracheal gills have delicate membranes subservient to an endosmosis of oxygen and exosmosis of carbonic acid. The stigmata occur in the thoracic regions, but are not functional in the larva and are closed by a delicate membrane. It is only when the animal is left exposed to the direct air—for instance, by the desiccation of the marsh in which it has lived—that functional activity for the spiracles supervenes. (J. R. M. S. (2), I, 730, from Bull Sc. Dep. Nord., IV, 115-120.)

#### *The proboscis of the Lepidoptera.*

The proboscis of the Lepidoptera has been examined by M. Breitenbach, with a view to determine its origin and the homologies of its parts. Without at all indorsing his views, we submit an abstract of them.

The proboscis is represented "in the early stages, for in the late larva it has been found already represented by two long, curved cords. But, further, the obvious connections of the group with the Trichoptera show that the biting mouth of the latter has produced the sucking tube of the former by modification of the labium, maxillæ, and labrum, which were first all united in a tubular organ; the edges of the two maxillæ then became more closely approximated, and the share of the other two parts in the organ became unnecessary, and they were excluded from it. This metamorphosis, however, was probably made in various stages, each having some definite advantage to the insect as its



object: *e. g.*, the exclusion of the labrum and labium from the organ was a beneficial simplification, the great object being to bring the two maxillæ together; the latter organs were able to assume a greater development in consequence of the reduction of the former; this development was further promoted by the abnormal method by which food was obtained. The increase in the length of the tube was caused by the depth which the nectaries of certain flowers exhibited, and by which they excluded insects hurtful to them, while, at the same time, this very depth allowed of the accumulation of a greater amount of honey."

Among other subjects treated of by M. Breitenbach in this connection are the structure and functions of the so-called juice-borers, which are discussed at considerable length. (J. R. M. S., (2,) II, 35-37, from Jen. Zeitschr. Nat., XV, 151-214, with 3 pl.)

#### *Devastations by Insects.*

Many millions of dollars are yearly lost to the farming community through the devastations of insects, and thereby the labors of the agriculturist are rendered more onerous than they would otherwise be, and not infrequently unremunerative. In order to avert as much as possible the ravages of these in size insignificant but in numbers formidable enemies, it has been deemed the part of wisdom by civilized governments to retain men skilled in the knowledge of insects and in investigations of their habits, to learn and teach the best means of meeting their attacks. The general government and several states have their special entomological bureaus, and each year reports are published in which some branch of economical entomology is considered. From the great mass of information relative to the subject published in 1881 we select the following notes.

*The Phylloxera.*—The devastations of the justly-named *Phylloxera vastatrix* on the vineyards of various countries have attracted much attention. The losses in many countries have been appalling. In France, for example, of the 2,200,000 hectares (about 5,500,000 acres) planted with vines nearly a quarter have been overrun and the plants practically destroyed, while as many more have been attacked (A. N., XV, 821). Strenuous efforts have been made to prevent the spread of the insects by different governments. In Italy, Spain, Turkey, Roumania, Algeria, and the Cape of Good Hope the introduction of all living plants is entirely prohibited; in Germany the restriction extends only to vine-plants, while in Switzerland, Austria-Hungary, and Portugal, introduction of "living plants" is permitted if attested by certificates to come from uninfected localities (A. N., XV, 821). So rigidly is the law enforced in some places that a cargo of potatoes arriving in Cape Town from New Zealand was destroyed for fear that the pest might be imported therein (A. N., XV, 239). Objection has been made, however, to such stringent

regulations, but "Dr. Maxime Cornu has lately submitted a report, in which, while confessing that *Phylloxera vastatrix* is confined to the grapevine and can flourish on no other plant, he yet recommends the following of the example set by Algeria, which is to forbid the introduction of all vegetable products whatever, except those absolutely required for consumption" (Riley, A. N., XV, 239). It has been found that the American vines enjoy at least comparative immunity from the attacks of *Phylloxera*, and large consignments of roots have been imported into France from the United States to replant the destroyed vineyards (A. N., XV, 322).

*Enemies of Rice.*—The rice plant in the Southern United States has suffered in past years from the attacks of two insects, both beetles, the *Chalepus trachypygus* and *Lissorhoptrus simplex*, and a third insect has now been added to the list of its formidable enemies; but the newly-discovered pest is the caterpillar of a Lepidopter—the *Laphygma frugiperda*. The last proved to be very destructive to rice plants in the summer of 1881 in Georgia, and was identified by Professor Riley. It had been known before as a scourge to various grasses and grains, but not as a special enemy of the rice. In the East Indies a third order of insects—the Diptera—has contributed an additional and very formidable pest to the rice cultivator. It is the newly-discovered *Cecidomyia oryzae*, of which no congener had previously been known to occur in India. (Riley, A. N., XV, 148, 482, 751.)

*Enemies of Pastures.*—Another insect, which has long been known, but had not been hostile to the industry of man, in 1881 assumed a new rôle, and attacked pastures in the Eastern States—especially in parts of New York and New Jersey—"some fields as large as forty acres being ruined and others showing only dead spots of a rod or two square." The injurious larvæ were supposed by the farmers to be "army worms," but specimens were identified by Professor Riley as representatives of two distinct species, and both different from the true army worm. One of the destructive "worms," and the more common, at least in some sections, was the larva of *Crambus vulgivagellus*, and the other that of *Nephelodes violans*. Professor Riley well remarks, that "the widespread appearance and injury" of the former species during the past year "furnishes an excellent illustration of the fact that species which have never before been looked upon as injurious to agriculture may suddenly become so." (A. N., XV, 574-577, etc.)

*Enemies of Clover.*—The American agriculturist may have to encounter still another enemy of his labors—a curculionid beetle—the *Phytonomus punctatus*. It has been until recently unknown in the United States, but was detected in 1881 in Barrington, Yates County, New York, and specimens were sent thence to Professor Riley, with the statement that it had greatly injured the clover in that region. The insect is a common European species, but has not been known heretofore to do any serious harm to crops. Professor Riley adds that it is worthy of remark that

this imported enemy of clover made its first appearance in the same county which, three years before, furnished him with "another European beetle affecting the same plant—the *Hylesinus trifolii*, or "clover root-borer." (A. N., XV, 750-751, 912-914.)

*Insect Antidote.*—With enemies so numerous and increasing the agriculturist must be on the alert, and to render his labor remunerative requires to have antidotes to their ravages at a minimum cost. The seeds of species of *Pyrethrum*—*P. roseum* and *P. cinerariaefolium*—ground to powder, furnish one of the most effective insecticides. The *Pyrethrum roseum* "the only species of its genus," according to Dr. Rodde, "which gives a good, effective insect powder, is no where cultivated, but grows at an altitude of 6,000 to 8,000 feet," in Asia, the Caucasus, and southward. The *P. cinerariaefolium* is a Dalmatian species, of which little is known, but which is said to be cultivated in Dalmatia. In spite of the jealousy of the natives of the countries where these plants grow, seeds have been imported into the United States, and Professor Riley planted some in Washington, in the fall of 1880, which "came up quite well in the spring, and will perhaps bloom the present year." It would seem that the *Pyrethrum* is quite an effective insecticide, and its acquisition and retail at a moderate cost will be doubtless a great boon to the agriculturist. For detailed information as to cultivation, manufacture, and use of the plant we must refer to Professor Riley. (A. N., XV, 242, 569-572, 744-748, 817-819.)

*Carnivorous Beetles partly herbivorous.*—Even insects that are generally beneficial to the agriculturist by preying on his enemies, sometimes turn round and become destroyers of crops. Species of Carabidæ and Coccinellidæ, *e. g.*, have been found to change their usual carnivorous habits for a herbivorous diet, according to Professor Forbes, of the Illinois State laboratory. Representatives of 17 different species of Carabidæ were examined, and 11 of them were seen to have in their stomachs "either the spores of different fungi, the pollen of flowers, or the seeds of grasses and grains." The Coccinellidæ were ascertained to be to even a still greater degree herbivorous, and one of them—the *Megilla maculata*—"was proven to feed also upon the anthers and pollen of grasses," and, in fact, to almost rival in its herbivorous tendencies the squash-beetle (*Epilachna borealis*), which had been supposed to be exceptional in the family for its herbivory. The *Megilla* had been charged before with sometimes injuring crops, and a farmer of Saint Inigoes, Md., reported to Professor Riley considerable injury done by them "to corn by eating holes in the blades, and specimens of blades that were perforated and riddled accompanied the beetles."

So far, however, is this tendency to change of diet from being an unmixed evil to the agriculturist, it has been urged by Professor Forbes, that it renders these insects more valuable to man. In his own words, "as a prudent sovereign finds it worth while to maintain a much larger fighting force than is necessary to the ordinary administration of his

government, in order that he may always have a reserve of power with which to meet aspiring rebellion, so it is to the general advantage that carnivorous insects should abound in larger numbers than could find sustenance in the ordinary surplus of insect reproduction. They will then be prepared to concentrate an overwhelming attack upon any group of insects which become suddenly superabundant. It is evidently impossible, however, that this *reserve* of predaceous species should be maintained, unless they could be supported, at least in part, upon food derived from other sources than the bodies of living animals." (A. N., XV, 323-327.)

#### *Wings of Insects.*

The details of structure of the wings of insects and the contiguous parts, especially those of the family Libellulidæ, have been investigated by Mr. R. von Lendenfeld. The monograph of the alar structures of the Dragon-flies is especially noteworthy. "Sixty-two separate skeletal parts are named and described," and also "16 muscles and 2 ligaments." "A diaphragm of chitin separates the muscles for the wings from those for the legs; the exoskeleton is made up of thin chitinous plates. There are various methods of articulation, some of which are exactly comparable to those that are found in the vertebrata."

The Libellulidæ and "Neuroptera planipennia" are considered by Mr. von Lendenfeld to be the lowest of typical insects, on account of the equality in size of the wings, while those "with one pair of wings appear to be the most highly organized and possess the largest brain." The rank of the other groups is sought to be determined by the relative development of the two pairs of wings. It is probable, however, that the logic employed, as well as the conclusions deduced, will be opposed by many entomologists. Probably more satisfactory are the author's observations of the mode of flight.

A method for instantaneously photographing insects' wings was devised and is detailed by Mr. von Lendenfeld. "Two phases are to be distinguished in the movement of the wing—the movement from behind forwards, and from in front backwards. In both, however, there is an upwardly-acting force; with this there are associated other movements, resulting in the course of the wing being a more or less complicated curve, the directions of which depend, of course, on the extent to which these other forces act." (J. R. M. S. (2), II, 184-185, from Sitzungsber. Akad. Wiss. Wien, LXXIII., 289-376, with 7 pl.)

#### *Relations of Devonian Insects to existing types.*

The fossil insects have been for some years the special subjects of Mr. Samuel H. Scudder's studies, and the conclusions which he has reached respecting the relations of the Devonian forms to later ones have been published, and are as follows:

- (1) The insects have preserved their general type of wing structure

unaltered from the earliest times to the present; (2) they were hexapods; (3) they were all lower *Heterometabola*; (4) nearly all are synthetic types of a comparatively narrow range; (5) nearly all exhibit marks of affinity to the carboniferous Palæodictyoptera, but (6) they often manifest *more* complicated structure than most Palæodictyoptera; (7) they mostly bear little special relation to carboniferous forms, and have a distinct facies of their own; (8) they were "of great size, had membranous wings, and were probably aquatic in early life"; (9) some were precursors of existing forms, while others became extinct; (10) they flourished under a remarkable variety of structure; (11) they differed "remarkably from all other known types, ancient or modern, and some of them appear to be even more complicated than their nearest living allies"; (12) they show no more evidence of primitive type than the carboniferous insects; and (13) "while there are some forms which to some degree bear out expectations based on the general derivation hypothesis of structural development, there are quite as many which are altogether unexpected, and cannot be explained by that theory without invoking suppositions for which no facts can at present be adduced."

Some of these conclusions (4, 7, 8, 9, 10, 12) coincide quite well with those derivable from the survey of other classes of the animal kingdom, *e. g.*, fishes, *so far as they are known*, but the deductions probably sometimes rather represent the imperfection of the geological record than the facts as they were, and several of the conclusions (*e. g.*, 8, 11) are perhaps rather too sweeping. But whatever may have been the facts, the studies of Mr. Scudder have materially increased our knowledge of the palæozoic faunas, and his deductions are especially interesting for comparison with other classes of the organic kingdoms of nature. (A. J. S. (3), XXI, 111-117.)

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*Eyes of Gastropods.*

Dr. P. Fraisse has investigated the structure of the eye in three species of Gastropods representing two orders, viz: *Patella* of the order Docoglossa and *Heliotis* and *Fissurella* of the order Rhipidoglossa.

In *Patella* the eyes are minute vesicles; the retinal cells pass directly into the epithelial. Pigment occurs chiefly in the cells opposite the pupil.

There is no ommatophore; the optic nerve is also not developed, and the lens and vitreous body are equally deficient. The eye of this form is therefore considered to represent an embryonic stage in development.

In *Haliotis* the eyes are large and (as in *Patella*) there is an open cup; the cells pass from one to the other. Pigment is only found around the orifice of the cup. Retractable ommatophores support the eyes; optic nerves are developed of a remarkable character; each divaricates into two or three branches before entering the eye, and the latter expand and inclose the entire eye, coming into direct connection with the retinal cells. A lens of gelatinous substance is found and a vitreous body occupies a large part of the eye cup. The eyes are invested in loose connective tissue, and there is no sclerotic nor any other investing membranes.

In *Fissurella* the eyes lie just below the epidermis and the corneal cells are separated from the epithelial by a delicate layer of connective tissue. The "retinal cells belong to two groups; they may be long and very delicate at their lower ends, or they may be broader and thicker and more closely granulated, and the latter are moreover destitute of pigment. These thicker basal cells are regarded by the author, not as supporting cells of the true retinal elements, but as those organs from which the lens and vitreous body are developed; the pigmented cells alone function as the end-organs of the optic nerve."

In fine, the author's investigations have led him to conclude that the eyes of mollusks begin their development by an invagination of the epidermis which is originally open to the exterior; as this becomes shut off, the retinal cells become developed out of the epidermal cells. The eyes of *Patella* present the simplest known condition. "In *Nautilus* the eye is likewise open to the exterior, and in the *Hirudinea* [leeches] we may find organs of a somewhat similar construction. In cases of this kind the use of the term *retina* should be avoided, and be replaced by that of *rod-cells*. The cells which appear to be the organs for the perception of light are very characteristically developed in the Mollusca; what is here seen almost in diagram is found more or less distinctly in all other mollusks. The so-called retina consists of a series of elongated cells, the anterior portion of which is filled up by dark pigment. This pigment is more or less marginal in position, so that there is in the center an unpigmented cylindrical canal which passes directly into the unpigmented part of the cell." (J. R. M. S., (2,) I, 724-725, from Z. W. Z., XXXV, 461-478.)

#### *The Neomeniæ and Chætodermæ.*

One of the most interesting groups of Invertebrates is that represented by the genera *Chætoderma*, *Neomænia*, and *Proneomænia*.

The representatives of this type have been associated with very diverse groups by various authors; by some with the worms, by most with the mollusks; and in the branch of mollusks, by some with the *Nudibranchiæ*; but by the majority of anatomists with the *Chitons*. Although few in number and of rare occurrence, or rather only found by



careful search in the proper habitats, they have received considerable attention within the last few years, and to Prof. A. A. W. Hubrecht, of Leyden, we are indebted for an elaborate memoir on the group, published in 1881.

The most conspicuous feature of the group is "the presence of four longitudinal nerve-trunks, united together into one in front of or above the pharynx," and coalescing behind in whole or part (two of them) into a ganglionic swelling above the rectum.

In all the genera of the group "a heart, situated dorsally close to the posterior extremity of the body, a median dorsal and a median ventral blood-vessel, are the principal parts of the circulatory apparatus." The respiratory apparatus is variable. In *Chætoderma* and *Neomenia* retractile branchiæ are developed at the posterior extremity of the body, in *Chætoderma* being paired and in *Neomenia* being tuft-like; in *Proneomenia* special branchiæ are absent, and respiration is supposed to be effected through the wall of the intestine and the foot, "and perhaps more especially in the rectum."

There is a decided difference, it seems, in the relations of the sexes in the two primary groups of the class. The *Chætodermidæ*, like the *Chitonids*, have the sexes separate, while the *Neomæniidæ* are monœcious or hermaphrodite. There is a direct communication between the ovary and pericardium (at least, in *Chætoderma* and *Proneomenia*), and the pericardium also communicates with the exterior by a system of ducts and passages. Such ducts, in part, at least, are considered as renal organs. "And so the *Solenogastres* exemplify a primitive stage, in which the pericardium (body-cavity) receives the oviducts on the one hand, and on the other communicates with the exterior by means of the nephridia."

It is maintained by Dr. Hubrecht that the deviations in this type are rather manifestations of degradation or atrophy of parts than of incipency and original non-development. The radula has been aborted or lost, and not failed. The condition of the nervous system is expressive of a reduction of type and is not a primitive stage, and the inferior development of the intestine and liver is likewise to be looked upon as a result of reduction.

#### *Americanized European Shells.*

Several species of well-known European shells have been introduced into the waters of the Atlantic coast within recent years. A common shell of England—*Littorina littorea*—was found on the shores of Maine as early as 1868, and still earlier as an inhabitant of Nova Scotia. But several closely related species were already known as common American forms. During the past year, however, two distinct family forms have been added to the American Fauna—*Truncatella truncatula*, the type of the family of *Truncatellidæ*, and *Assimineæ grayana*, also a type of a peculiar family, the *Assiminiidæ*. Both were found for the first time by Professor Verrill among the docks of Newport, R. I., at high water.

*Land shells of the palæozoic era.*

The geological history of the Pulmonates is a most remarkable one in more respects than one. So far as the evidence appeared until comparatively lately, with a limited spot in Nova Scotia unknown, the palæontologist might have felt justified in declaring that the order was "ushered in" with the tertiary epoch. But as long ago as 1852, Lyell and Dawson indicated the existence of a minute pupa-like shell in the carboniferous period on the testimony of a specimen found in 1851 within the hollow of an erect fossil tree at the "South Joggins," Nova Scotia. Subsequently the form was named *Pupa vetusta*. In the same place were afterwards (in 1866) discovered specimens of another land shell, resembling the species of the existing helicoid genus *Conulus*. In 1869, Prof. Frank H. Bradley made known two other terrestrial mollusks in the carboniferous rocks occurring at Pelly's Fort, on the Vermillion River, in Illinois, one a pupoid and the other a helicoid. \*In 1880, Principal Dawson added a third species of land shell obtained from the Joggins, with the so-called *Pupa vetusta*, which he called *Pupa Bigsbyi*. Still more, he described a shell from Devonian rocks of New Brunswick which he considered to be a new generic type and named *Strophites grandæva*. Finally, during the past year Mr. R. R. Whitfield has made known a coal measure pupoid shell, which he has designated as a peculiar generic form, naming it *Anthracopupa Ohioensis*. Seven Palæozoic Pulmonates have thus been made known, viz; Devonian: *Strophites grandæva*.—Carboniferous: *Dendropupa vetusta* (N. S.), *Pupa* [?] *Bigsbyi* (N. S.), *Pupa* [?] *Vermilionensis* (Ill.), *Strophites grandæva* (N. B.), *Anthracopupa Ohioensis* (O.), *Conulus priscus* (N. S.), and *Dawsonella Meekii* (Ill.).

So far as can be determined from the shells, and even the associations, all these mollusks, except, perhaps, the last (*Dawsonella Meekii*), were true land Pulmonates, related to the existing Pupidæ and Helicidæ. That any of them belonged to the restricted genus *Pupa* is very doubtful, and Owen has proposed the name *Dendropupa* for the earliest species made known. This is not the place, however, to discuss their intimate affinities. As to the *Dawsonella*, its helicoid relations are at least extremely dubious. It has considerable resemblance to a Helicinid, and Mr. Whitfield "cannot but come to the conclusion that *Dawsonella* was an operculated shell" and probably related to *Helicina*. This genus, be it recalled, cannot be associated with the true Pulmonates, but is allied to the aquatic Neritidæ, etc. None of the operculate terrestrial mollusks are, in fact, at all related to the Pulmonates, properly so called, the Cyclostomidæ being most nearly related to the marine Littorinidæ of the order Pectinibranchiata, and the Helicinidæ, as just remarked, of the Neritidæ, and representing the order Rhipidoglossa.

The Pulmonates then, it appears, existed in the Devonian and Carboniferous periods in forms little different from some now living, and

none are known from the rocks intervening between the last and the tertiary. Nevertheless, no reasonable naturalist will doubt that they did exist in that intervening period, and few now would believe that the devonian forms were not preceded by kindred types. The distribution of the order is therefore a striking exemplification of the "imperfection of the geological record." (A. J. S., (3,) XX, 403-415; XXI, 125-128.)

*Shells of Lake Tanganyika.* •

As a rule there is something in the appearance and texture or epidermis of true fresh-water shells which enables the conchologist at once to recognize them as such, even though they be quite different from any forms he has previously known; but in a Central African lake—Lake Tanganyika—peculiar univalve shells have been discovered which are remarkable for their unlikeness to any fresh-water forms before known, and conversely for their resemblance to marine shells. The mimic forms have been designated as follows:

- (1.) LIMNOTROCHUS (E. A. Smith, Ann. Mag. Nat. Hist. (5), v. 6, p. 425, 1880; P. Z. S., London, 1881, 285).

This is said to "have all the appearance of a *Trochus* when viewed with the aperture from the eye. It is, however, more closely related to the Littorinidæ, and exhibits the greatest affinity with the genus *Echinella*." Two species have been discovered, one of which (*L. Thomsoni*) has an especial resemblance to an *Echinella*, while the other (*L. Kirki*) reminds one, by form as well as sculpture, of a *Solarium*.

- (2.) SYRNOLOPSIS (E. A. Smith, Ann. Mag. Nat. Hist. (5), v. 6, p. 426, 1880; P. Z. S. L., 1881, 288).

This "curious form has all the appearance of a marine genus, in fact, closely resembling *Obeliscus* or *Syrnola*." Mr. Smith believes "it may temporarily be classed with the Rissoidæ."

- (3.) TIPHOBLA (E. A. Smith, P. Z. S. L., 1880, 348; 1881, 293).

This form is thought by Mr. Smith to be "perhaps the most remarkable species of fresh-water mollusca yet discovered." It reminds one of a "*Pyrula*," but still more of a "*Rapana*," while it also may recall to mind the *Glotella armigera* of the United States.

- (4.) TANGANYICIA (Crosse, Journ. Conchol., (3,) t. 21, p. 287, 1881).

The species of this group somewhat resemble Naticids, but they also approach the Ampullariids.

- (5.) SPEKIA (Crosse, Journ. Conchol. (3), t. 21, p. 302, etc., 1881).

This "subgenus" of "*Lacunopsis*" has been proposed for the "*Lithoglyphus zonatus*" of Woodward, a shell peculiar for its thickness, and thus recalling certain Littorinæ, but related to a fluviatile mollusk of China.

- (6.) "MELANIA (—?) Horei" (E. A. Smith, P. Z. S. L., 1881, p. 292).

This shell is said by Mr. Smith to be "another instance of a species

from Tanganyika, having very much the appearance of a marine form." What particular "marine form," if any, is meant is not specified, but the figure reminds one of a *Planaxis*.

Two other sub-genera or genera complete the list of peculiar types discovered in the African lake. They are—

PARAMELANIA (E. A. Smith, P. Z. S. L., 1881, p. 558)

NEOTHAUMA (E. A. Smith, P. Z. S. L., 1880, p. 349; 1881, p. 293).

The former is a Melanoid; the latter a Viviparine gastropod with the labrum "deeply emarginate" and reflected.

The discovery in a single body of water of such an association of peculiar and limited types, and with such a facies is unexampled in the annals of conchology. In the opinion of Mr. Smith, three of these, especially the species of *Limnotrochus* and *Syrnolopsis*, "have all the appearance of being modified marine types; and such is probably the case," he adds, for, "judging from the geology of the neighborhood, Tanganyika at some remote epoch has been an inland sea, the saltness of whose waters has almost entirely vanished, leaving only a *peculiar* taste, which can scarcely be described as brackish" (P. Z. S., 1881, 276-277). Their presence involves one of the most difficult malacological problems, thinks Mr. Crosse (Journ. Conchol. (3), t. 21, p. 303); but while he retains *Limnotrochus* in the *Littorindæ*, he is very doubtful whether the soft parts of *Syrnolopsis* will confirm its reference to the same family with *Syrnola*.

It is very regrettable that the soft parts of the several genera discovered should remain unknown. The opercula seemed to have been intact in some of the shells, and probably, therefore, the lingual ribbons could with proper care have been found. Their examination alone would have permitted a determination, at least, approximative, of the mollusks, affinities. Until such examination the question of relationship must remain doubtful. It may be suggested, however, that the variations of the shells, considerable and remarkable as they are, are not incompatible with their association with the Melaniids, for they can be derived from the same type. But whether the new genera are much modified Melanians, (or Viviparids,) or related to marine forms, or representatives of even peculiar families, must remain unsettled till the lamentable neglect to search for and examine the odontophores at least is repaired. Meanwhile the most conservative course would be to associate them with doubt in the family of Melanians. The deductions of Mr. Smith as to the geological relations of the lake forms do not appear to be warranted.

Lake Tanganyika has now contributed to conchology 32 species, representing 19 genera; 20 species and 6 genera or sub-genera have not been detected elsewhere; 8 species are known to be also found in the Nile.

As to the *Paramelanix*, Dr. C. A. White, of Washington, has expressed the opinion that there is a generic identity between those species and the *Pyrgulifera humerosa* of Meek, described about five years

before (U. S. Geol. Surv. 40th Par., v. 4, p. 176, pl. 17, f. 19, 19 a) from specimens obtained in the Laramie group, "which holds a transitional position between the Mesozoic and Cenozoic series" (Nature, v. 25, pp. 101-102). Dr. White also was of the belief that the "*Melania (Sermyla) admirabilis*" of Tanganyika Lake is "evidently congeneric with" the "*Goniobasis Oleburni*," described by him from the same formation. Mr. Smith, however, thought that it was "decidedly unadvisable at present to locate the two forms in question in the same genus" (Nature, v. 25, p. 218). In view of the known facts of distribution coincident with structural characteristics of the Melaniids and related forms, it seems to be premature, without direct comparison, to identify the extinct American and living African shells as congeners.

The quasi-representative forms are probably not only not *isotypes*, but simply *mimotypes*, and it is quite improbable that any of the American Melaniiform mollusks are *necrotypes*\* of Africa.

#### CEPHALOPODS.

##### *Dibranchiata.*

Girod (P.). Structure et texture de la poche du noir chez les Céphalopodes des côtes de France. *Compt. rend. Acad. Sc., Paris*, t. 92, pp. 966-968.

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———. Das Verhalten der Siphonaldücte und die Descendenz der Cephalopoden. *Kosmos*, v. 9, pp. 145-149.

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Yung (E.). Recherches expérimentales sur l'action des poisons chez les Céphalopodes. *Mittheil. Zool. Station Neapel*, v. 3, pp. 97-120.

Verrill (A. E.). Giant Squid (*Architeuthis*) abundant in 1875 at the Grand Banks. *Am. Journ. Sc.* (3), v. 21, pp. 251-252; *Ann. & Mag. Nat. Hist.* (5), v. 7, pp. 351-352.

##### *Gigantic Cuttle-Fishes.*

The gigantic cuttle-fishes have been specially studied by Professor Verrill, and much light has been thrown on the subject by his researches. The largest of the class appear to belong to the family of Ommastre-

\* The geography of animals and plants may be discussed with increased precision and terseness by the use of several terms, e. g.:

MIMOTYPES (*μιμος*, mimic; *τυπος*, form): Forms distantly resembling each other, but fulfilling similar functions, and thus representing each other in different faunas; e. g., (1) the Shrews of Europe are mimotypes of the *Antechinus* of Australia; (2) the Sloths of South America, of the *Phascogale* of Australia, etc. By the use of this term, the word "analogue" may be relieved of a part of the burden borne by it.

ISOTYPES (*ισος*, equal or like; *τυπος*, form): Forms common to different countries; e. g., the Shrews are isotypes in Europe and North America, etc.

NECROTYPES (*νεκρος*, dead, and *τυπος*, form): Forms formerly existent in a country, but now extinct; e. g., the horses and rhinoceroses are necrotypes of North America, indigenous species having once flourished on that continent, but become exterminated in prehistoric times.

phididæ, and the genus appropriately named *Architeuthis*, i. e., chief of the cuttle-fishes. Two of those are recorded as having an extreme length of 52 feet. In one (*A. princeps*?) the body from the base of the arms to the tip of the tail was 15 feet long. Another, still larger, was 55 feet in extreme length, and its body was 20 feet long. It may be well to add that the large cuttle-fish lately exhibited in New York and through the country was very badly, indeed grotesquely, prepared by the taxidermist, and gave no idea of the real animal.

## MOLLUSCOIDS.

## POLYZOANS.

Hincks (Thomas). Contributions toward a General History of the Marine Polyzoa. *Ann. Mag. Nat. Hist.*, (5), v. 8, pp. 122-136.

## BRACHIOPODS.

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Douville (H.). Note sur quelques genres de Brachiopodes. *Neues Jahrb. f. Miner. Geol. Palæontol.*, 1881, v. 1, pp. 438-440.

## PROTOCHORDATES.

## TUNICATES.

Herdmann (W. A.). Notes on British Tunicata, with descriptions of new species. 1. Ascidiidæ. *Journ. Linn. Soc. London; Zool.*, v. 15, pp. 274-290, 6 pl.

———. "Olfactory Tubercle" of Simple Ascidiæ. *Journ. R. Microscop. Soc.*, (2), v. i, p. 5; Oct., p. 726. (*Proc. R. Phys. Soc. Edinburgh.*)

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Joliet (L.). Remarques sur l'anatomie du Pyrosome. *Compt. rend. Acad. Sc., Paris*, t. 92, pp. 1013-1015.

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## VERTEBRATES.

## GENERAL.

Heldreich (—). Vertebrados de Grecia. *Cronica cientif., revista internac. de cienc., Barcelona*, 1879.

Hertwig (O.). Die Entwicklung des mittleren Keimblatts der Wirbelthiere. *Jena. Zeitschr. für Naturwiss.*, v. 15, pp. 286-340. Also published at Jena, by G. Fischer, 1881, as Studien zur Blättertheorie von O. und R. Hertwig, Heft V.

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Loos (P. A.). Die Eiweissdrüsen der Amphibien und Vögel. *Zeitschr. f. wiss. Zool.*, v. 35, pp. 478-504, 1 pl.

- Reizius (Gust.). Das Gehörorgan der Wirbelthiere. Morphologisch-histologische Studien. I. Das Gehörorgan der Fische und Amphibien. Mit 35 Taf. Stockholm, Samson und Wallin, 1881. (gr. 4to. xi, 222 pp., 35 Bl. Tafelerklärung.)
- Schulin (Karl). Zur Morphologie des Ovarium. *Arch. f. mikroskop. Anat.*, v. 19, pp. 442-512, 3 pl.

*Development of paired limbs.*

Several naturalists—*e. g.*, MacIise, Humphrey—had long ago suggested that the paired fins were morphologically parallel with the median ones, but, on account of the crudity of their conceptions and the insufficiency of the evidence adduced, they failed to convince their fellow-workers of the soundness of their conclusions. Later, Mr. F. M. Balfour was led to "the conclusion that the vertebrate limbs were remnants of two continuous lateral fins" by the study of their development, and soon after Mr. J. K. Thacher, of New Haven, and following him Mr. St. George Mivart, reached the same results through anatomical studies. Objections having been raised against the soundness of these conclusions, the subject was re-examined in 1881 by Mr. Balfour, by reference to the development of the pectoral and ventral fins in Scylliids as well as their structure in the adult. After paying due attention to the observations and criticisms of several naturalists—especially Davidoff and Gegenbaur—he reiterates the opinion that "the skeleton of both the paired and the unpaired fins of Elasmobranchs and *Lepidosteus* is in its development independent of the axial skeleton," but admits that "the phylogenetic mode of origin of the skeleton, both of the paired and of the unpaired fins, cannot, however, be made out without further investigation." He aptly dissents (as the recorder did in 1872) from Gegenbaur's view as to the archypterygium, and also, but apparently with far less reason, from the "derivation of the folds, of which the paired fins of the Vertebrata are supposed to be specializations, from the lateral folds of *Amphioxus*." His reasons for dissent in the latter instance have not been given. It may be added, in this connection, that the ancestors of the Myzonts probably had the lateral fins, and their absence in all the surviving members of the class is doubtless due to the elongation of the body. (*P. Z. S.*, 1881, 656-671, pls. 57, 58.)

FISHES IN GENERAL.

ANATOMY.

*Integumentary system.*

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*Osseous system.*

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*Muscular system.*

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*Nervous system.*

Cattie (J. Th.). Vergelijkend-anatomische en histologische Onderzoekingen van de Epiphysis cerebri der Plagiostomi, Ganoidei en Teleostei. Leiden, S. C. van Doesburgh, 1881. (8vo. 104 pp., 3 pl. M. 3.)

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Zelinka (Carl.). Ueber die Nerven in der Cornea der Knochenfische. *Zool. Anz.* 4. Jahrg., pp. 338-339.

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Brass (A.). Die Accommodation des Auges der Knochenfische. *Zeitschr. f. d. ges. Naturwiss.*, v. 53, pp. 901-903.

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Cisow (A.). Ear of Ganoids. *Journ. R. Microscop. Soc.*, (2,) v. 1, pp. 429-430. (Abstract.)

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Bell (H. Jeffrey). Eye-like Spots in Fishes. *Pop. Sc. Rev.*, n. s., v. 5, pp. 221-234, pl. 6, July, 1881.

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Leydig (Franz). Die augenähnlichen Organe der Fische anatomisch untersucht. Bonn, E. Straub, 1881. (8vo, 100 pp., 10 pl. M. 13, 50.)

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*Taste.*

Jourdan (E.). Sur les organes du goût des Poissons osseux. *Compt. rend. Acad. Sc., Paris*, t. 92, pp. 743-745.

*Gills.*

Riess (Albin). Der Bau der Kiemenblätter bei den Knochenfischen. *Arch. f. Naturgesch.*, 47. Jahrg., v. 1, pp. 519-550, 3 pl.

*Lymphatic system.*

Trois (Enrico F.). Contribuzioni allo studio del sistema linfatico dei Teleostei. Ricerche sul sistema linfatico dell' *Uranoscopus scaber*. *Atti R. Istit. Veneto Sc., Lett. ed Arti*, (5,) t. 6, pp. 404-418, 1 pl.

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*Generative system.*

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*Ontogeny.*

Hoffmann (C. K.). Zur Ontogenie der Knochenfische. *Naturk. Verhandl. K. Akad. Wet. Amsterdam*, v. 21 (168 pp., mit 7 Taf.).

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Doderlein (P.). Manuale ittologico del Mediterraneo. P. I. Bibliografia ittologica. P. II. Sinossi metodica delle specie. Fasc. I. Epibranchi, Elasmobranchi. Palermo, 1881. (8vo. I, 67 pp.; II, 117 pp.)

Morveau (Em.). Histoire naturelle des Poissons de la France. Paris, G. Masson, 1881. (8vo. 3 vols., viz, v. 1, 480 pp.; v. 2, 576 pp.; v. 3, 701 pp.; fres. 60.)

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*South America.*

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*Pacific Ocean.*

Günther (A.). Garrett's Fische der Südsee. Heft 7 (pp. 217-256, 20 Taf.). Hamburg, 1881. *Journ. Mus. Godeffroy*, Heft 15.

*Australia.*

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## FISHERIES.

*General.*

- Amtliche Berichte über die Internationale Fischerei-Ausstellung zu Berlin 1880. Berlin, P. Parey, 1881. (8vo.) viz: I. Fischzucht von M. von dem Borne, H. Haack, K. Michaelis. Im Anhang: die Angelfischerei, von M. von dem Borne. Mit 39 Holzschn. (84 pp.) II. Seefischerei, von Dr. M. Lindemann. Mit 162 Holzschn. (244 pp.)
- Meyer (J.). Handbuch des Fischerei-Sports. Wien, Pest, Leipzig, Hartleben's Verlag, 1881. (8vo. 272 pp. M. 5. 40.)
- United States Commission of Fish and Fisheries. Part VI. Report of the Commissioner for 1878. (A. Inquiry into the decrease of food fishes. B. The propagation of food fishes in the waters of the United States.) Washington, Govt. Printing Office, 1880. (8vo, liv and 988 pp.; published 1881.)

*Fish epidemic.*

- Endlich (F. M.). An Analysis of Water destructive to Fish in the Gulf of Mexico. *Proc. U. S. Nat. Mus.*, v. 4, p. 124.
- Farlow (W. G.). Report on the contents of two bottles of Water from the Gulf of Mexico, forwarded by the Smithsonian Institution. *Proc. U. S. Nat. Mus.*, v. 4, p. 234.
- Glazier (W. C. W.). On the destruction of Fish by polluted waters in the Gulf of Mexico. *Proc. U. S. Nat. Mus.*, v. 4, pp. 126, 127.
- Ingersoll (Ernest). On the Fish mortality in the Gulf of Mexico. *Proc. U. S. Nat. Mus.*, v. 4, pp. 74-80.
- Johnson (S. H.). Notes on the Mortality among Fishes of the Gulf of Mexico. *Proc. U. S. Nat. Mus.*, v. 4, p. 205.
- Moore (M. A.). Fish Mortality in the Gulf of Mexico. *Proc. U. S. Nat. Mus.*, v. 4, pp. 125-126.
- Porter (Joseph V.). On the destruction of Fish by poisonous water in the Gulf of Mexico. *Proc. U. S. Nat. Mus.*, v. 4, pp. 121-123.

*Fishes of Alaska.*

Fishes had been collected in Alaska and scientifically described long before any were made known from California, but while the fauna of the latter was in later years well studied, that of Alaska remained comparatively neglected. But several collectors have gathered there within a few years past, and Dr. Tarleton H. Bean, in 1880, visited the country to study the fishes and fisheries, and has, since his return, published a number of articles respecting them, and compiled "a preliminary catalogue of the fishes of Alaskan and adjacent waters." (*Proc. U. S. Nat. Mus.*, v. 4, pp. 239-272.) One hundred and sixteen species are enumerated, all of which but seven are represented in the National Museum. The species are almost wholly shore fishes, or such as are found in comparatively shallow water, scarcely any deep-sea forms having been discovered. We need only add here that the Cod family is represented by 6 species, the Flounder family by 9, the Sculpins by 21, the Chiridæ by 8, and the Salmon family by 9. Two very interesting genera have been added by Dr. Bean to the fauna which are at the same time new to science, *Melletes*, a kind of Sculpin, and *Dallia*, a fish related to the Mud fishes, or Umbridæ.

*Fish epidemics in the Gulf of Mexico.*

In different years, at considerable intervals, an unusual mortality has occurred among the animals of the Gulf of Mexico around the peninsula of Florida, and fishes in large numbers and of many species could be then found floating, dead or dying, at the surface or stranded on the shore. The years 1844 and 1854 are especially remembered on account of the fatality among the inhabitants of the Gulf. In the fall of 1878 there was also a notable epidemic. (Jefferson, &c., in Proc. U. S. Nat. Mus., v. 1, pp. 244-246, 363, 364.) In the fall of 1880, likewise, occurred a destructive epidemic. These epidemics ensue on the presence and diffusion of bodies of discolored "poisoned water," which appear "in long patches or 'streaks,' sometimes 100 yards wide (and probably sometimes much wider), drifting lengthwise with the flow of tide," and which can be readily distinguished from the natural clear blue water of the Gulf. The sponges and other animals living near the bottom seem to be among the first to suffer, and profitable sponging grounds have been ruined by the poisoned stream. According to Mr. Ingersoll the epidemic of 1880 "began suddenly, and immediately followed the terrible hurricane which is known as the 'August gale,' the fish and all other ocean life suddenly dying in hordes all along the southern (eastern) shore of Tampa Bay, in Egmont Keys, at its mouth, which was the most northern point, and thence southward as far as Shark River, in Whitewater Bay, on the coast. Thence fatal localities were to be found in the currents that set southward through Bahia Honda passage, through the Northwest Passage beyond Key West, and even out in the neighborhood of the far isolated Tortugas." Not only are these masses of deleterious water fatal in their course, for numerous fishermen are compelled to cross it in going from their fishing grounds to their markets, and lose their cargoes on account of the transit. Various attempts at explanation have been made of the phenomena. The most popular seems to be a hypothesis that the dirty water is due to an overflow from the everglades or swamps of "fresh water poisoned by a decoction of noxious acids, &c., leached from the roots which had been soaking for years in the pent-up floods" (P. N. M., iv, p. 78), or which had been saturated with the dogwood (*Cornus florida*), especially. (P. N. M., iv, p. 122.) Another quite prevalent opinion attributes the unclean water to the eruption of a submarine volcano or "eruptions of volcanic gases which may have taken place through the bottom of the sea along a line stretching from Tampa Bay to the Tortugas and through the western half of the Florida Keys." (Ingersoll, P. N. M., iv, pp. 79, 80.)

In order to determine if possible the truth in a case which affects such large interests, both in labor and capital, the United States Fish Commissioner sent Mr. Ernest Ingersoll to Florida to collect evidence in the matter, and referred samples of the "poisoned water" to Dr. F. M. Endlich for chemical examination, and to Dr. W. G. Farlow for microscopical investigation.

Dr. Endlich, on analysis and comparison of the "poisoned water" with normal Gulf water, found the constituents to be, respectively, as follows, the injurious being designated as A and the normal as B:

	A	B
Specific gravity.....	1.024	1.022
Solid constituents (total), per cent.....	4.0780	4.1095
Ferric compounds, per cent.....	0.1106	0.0724
Injurious organic matter.....	ratio = 3	ratio = 2

He could not find, "even by spectroscopic analysis, any mineral constituents in the water A which could noxiously affect the fish," but he came to the conclusion that "the death of fish was caused by the more or less parasitic algæ, which are found in large quantities in water A, but do not occur at all in water B." (P. U. S. N. M., iv, 124.)

Professor Farlow, the eminent cryptogamist, to whom two bottles of the water were sent, found therein "a mass of amorphous slime, in which were numerous crystals, apparently of a fatty nature," as well as numerous and partially decomposed remains of small crustaceans and various plant tissues. It was his "opinion that the trouble is not caused by the presence of any vegetable substance, but that the presence of the latter is accidental. The slimy mass probably originated from a mass of eggs which, for some reason or another, were killed near the surface, and the smaller crustaceans in the neighborhood here have been involved in the general mass of slime." (*Op. cit.*, p. 234.)

Practically the results of the investigations so far have been negative. More data are required, the extent and course of the noxious currents should be ascertained, a rigorous co-ordination of all facts bearing on the question is requisite, and renewed chemical and microscopical investigations must be made, as well as careful examination of the dead and dying fishes, as to their gills, &c. The factors that have been assigned as causes of the disturbed waters, and the mortality among the fishes, are scarcely likely to be the efficient ones. It is useless to speculate at this time what are. It is most desirable in the interests of the fisherman, as well as science, that the truth should be known.

A communication of Mr. S. H. Johnson, the collector of customs at Corpus Christi, Tex., is of interest in this connection, but fails to give any solution to the question at issue. "After very heavy rains and overflowing of rivers, the inner bays on the Texas coast suffer a loss of from one-half to three-fourths of their salt-water fish, not including mullet, which live as well in fresh as salt water," and unusual cold weather is also quite fatal to fish in shallow waters. The percentages given are, of course, only of value as crude estimates based on superficial appearances. (Proc. U. S. N. M., IV, 205.)

## ICHTHYOLOGY.

The subjects of this "science" are separable under four classes: (1) the Leptocardians, (2) the Myzonts or Marsipobranchiates, (3) the Selachians, Sharks, Rays, and Chimærids, and (4) the true Fishes.

## CLASS OF LEPTOCARDIANS.

Hatschek (B.) Studien über Entwicklung des Amphioxus. Arbeit. Zool. Inst. Wien, v. 4, p. 1-88, 9 pl.

Hoppe-Seyler (F.) Über Amphioxus und Cephalopoden. Berichtigung. Zool. Anz., 4. Jahrg., p. 185-187.

Krukenberg (C. Fr. W.) Zur Kenntniss des chemischen Baues von Amphioxus lanceolatus und der Cephalopoden. Zool. Anz., 4. Jahrg., p. 64-66, p. 263, 1881.

*Embryology of Amphioxus.*

In some respects the most important vertebrate type known is *Amphioxus* or *Branchiostoma*. Were it not for this form we would be left in the dark as to the relationships of the great vertebrate with the other branches of the animal kingdom and could only at best surmise, and imperfectly, the truth in the case from the facts of the embryology of the Marsipobranchiates and succeeding animals. Whatever light is thrown on the history of *Amphioxus*, is consequently reflected on the genealogy and history of all other vertebrates, including man himself. A full knowledge of that form is therefore especially desirable. Numerous naturalists have contributed to our information respecting the morphology and histology of the adult stage, but few have done aught respecting the embryology. Years ago the eminent Russian embryologist, Kowalevsky, gave the first glimpses of the animal's earlier history, and during the past year Dr. Hatschek has added to the stock of information respecting its development, and confirmed, supplemented, and sometimes modified Kowalevsky's account. The ova are generally quite isolated. Oviposition seems to be dependent on the weather and even time of day. The generative products are discharged through the mouth, as Kowalevsky stated. The five fat-like bodies of the Russian author are regarded as yolk granules; the spermatozoa would appear to always enter at the vegetative pole. The progress of development is described as it appears at five different periods.

In the first period after the fecundation of the egg, segmentation ensues. The cleavage was found to be unequal, the differences between the two poles being well marked. There is a pause of about an hour between the formation of the first and second groove.

In the second, or "blastula-stage," the investing cells take on "an epithelial character till there is formed a general outer layer, inclosing a cavity. This simple epithelium forms the substratum for the later developmental processes. All the essential organs are formed by foldings or outgrowths from it. Bilateral symmetry is obvious at a very

early period; the blastopore appears to close from before backwards. The lower layer, which goes to form the endoderm, does not correspond to more than one-third of the blastula. This undergoes invagination; the fluid of the cleavage cavity becomes absorbed, and bilateral symmetry soon becomes well marked."

In the "'third period' the primitive segments, the nervous system, and the notochord begin to be apparent; the remnant of the blastopore persists as an opening between the enteric cavity and the nerve-tube, representing the typical neuro-enteric canal. Contemporaneously with the development of the nerve-tube, the mesoderm develops the primitive segments; two lateral longitudinal folds arise in the dorsal portion of the endoderm, and represent the rudiments of the mesoderm. The cavities of the primitive segments are diverticula from the arch-enteric cavity."

In the fourth histological differentiation especially supervenes. "The muscles become apparent; the notochord undergoes histological differentiation, and fibrous cords appear in the medullary tube. At the same time the larva alters greatly in form, becomes elongated and compressed, and takes on generally a piscine character. The increase in the number of primitive segments goes on but slowly, but what are formed gradually fuse in the median central line. Each muscle-cell has at first only a single fibril, which is continuous throughout the length of the body."

In the fifth period "those changes occur which enable the embryo to pass into the larva. A number of orifices are now formed—the mouth and the first gill-cleft, the orifice of the ciliated organ (or left endodermal sac), the club-shaped gland, and the anus. The body meanwhile increases in length, fresh segments being formed; a number of strong motile flagella may be seen to be developed from the cells, and all the tissues of the body are now formed of transparent protoplasm."

The first four of these phases successively manifested correspond to the first of "two well-marked stages, the one embryonic when it is effected at the cost of the nutrient material contained in the egg, and is very rapid. The fifth phase represents the second stage. At the close of the first the mouth is developed, and the first gill-cleft. The larva now begins to feed itself; its cells contain transparent protoplasm, and the developmental processes are very much slower." (J. R. M. S., (2) II, 174–176, from *Arbeit. Zool. Inst. Univ. Wien*, IV, 1–89, with 9 pl.)

## CLASS OF MYZONTS.

Scott (W. B.). Beiträge zur Entwicklungsgeschichte der Petromyzonten. Morpholog. Jahrb., v. 7, pp. 101-172, 5 pl.

*Embryology of the Lamprey.*

An important contribution, in the German language, to our knowledge of the development of the Petromyzontids is due to Mr. W. B. Scott, of Princeton, New Jersey. In the laboratory of Professor Gegenbaur, at Heidelberg, he instituted new investigations on the family in question, and has published the result in an elaborate memoir in Gegenbaur's *Morphologisches Jahrbuch* (v. 7. pp. 101-173, with 5 pl.). We can only notice a few of the fruits of his studies.

The gastrula is the result of a true invagination, (but it is not central as it is in *Amphioxus*,) and the overgrowth of the smaller elements. The notochord was found to be of endodermal origin as has been known to be the case in the Leptocardians, Selachians, true Fishes, Urodele Amphibians, Lacertilian Reptiles and Mammals. Eight pairs of branchial clefts are developed, but the foremost speedily disappears, and it is added that there is no evidence of the existence of gill clefts anterior to the first pair of the lamprey in any primitive vertebrate. The embryonic mouth develops into the mouth of the adult, while in the higher vertebrates, save the Teleost fishes, the medullary tube arises from the growth together of two folds in the lamprey. The folds are appressed, and "the medullary tube forms an inwardly projecting knob, which, when it is separated off from the ectoderm, is at first a solid tube, and only becomes hollow by the outgrowth of its cells." The sensory organ first developed is the auditory, and this appears just in front of the primitive vertebra (and not, as in the Selachians, at some distance from it). The brain is notable in that for some time "there is no tendency to folding; when it does occur it appears to be due to the sudden increase in growth of the median portion." The rudimentary olfactory organ was found to be primitively single (and not double, as described by Calberla).

Some of the observations and inferences of Dr. Scott, especially those on the germinal layer, have been since controverted by J. P. Nuel, (*Archives de Biologie*, t. 21, pp. 403-454, with 2 pl.), but the memoir noticed is one of sterling merit and noteworthy as the production of an American naturalist.

## CLASS OF SELACHIANS.

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- Marshall (A. Milnes). On the Head Cavities and Associated Nerves of Elasmobranchs. Quart. Journ. Mic. Sc., v. 21, pp. 72-97, 2 pl.

*Anterior termination of notochord in Selachians.*

It had been generally supposed that the notochord in all fishes terminated in front, back of the sella turcica, and this belief has been embodied in diagnoses of those animals as contrasted with the lowest of the vertebrates—the Leptocardians. Recently, however, the eminent German embryologist, Professor Reichert, thought that he could trace the notochord “through the cranial floor in front of and below the hypophysis.” Reichert’s observation was made on the embryo of a dog-fish (*Squalus acanthias*). Dr. Rabl-Rückhard has re-examined the same species with reference to the mooted question, and confirms the old view in opposition to Professor Reichert. After an examination of several specimens he formulated his conclusions as follows:

1. “At no period of its development has the embryo of *Acanthias* a notochord with its apex projecting beyond that part of the base of the skull which subsequently becomes the dorsum sellæ.”

2. “The hypophysis arises immediately in front of the apex of the notochord in the basal portion of that deposit of connective tissue which is termed the middle cranial trabecula.”

3. “The summit of this rudiment (Reichert’s processus sellæ turcicæ) does not pass into the later sella turcica, but becomes the adventitia of the basilar artery.”

It is added that “though it is certain that the notochord stops short of the hypophysis and lies behind (not beneath) it, this is not irreconcilable with Reichert’s other statement—that the chorda of young sharks at a certain period of development reaches to the frontal wall (*Stirnwand*). The cephalic flexure shows us that such a state of things is quite possible.”

Observations were also made on the morphology and development of the hypophysis and pineal gland. The results of the lamented Balfour are confirmed. In contradiction of Fritsch, it is maintained that “the pineal gland is developed just as among the higher vertebrates.” The sources of error which have led to contrary assertions are explained. (J. R. M. S., I, 9-11, from Morph Jahrb., VI, 535-570, 2 pl.)

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*Retinal vessels of fishes.*

Vessels in the retina of the eel have been described by W. Krause as well as by W. Müller, but on the other hand several competent anatomists have denied the existence of such vessels in fishes. Dr. G. Denissenko has, to some extent, reconciled the conflicting statements. In old eels that investigator was unable, like others, to find any vessels, and in old carp, although vessels were found; they were very insignificant, and might easily be overlooked. In the young carp, however, "they occur not only in the innermost layers, but also in the outer granular eye." Dr. Denissenko was consequently led to believe, with Krause, that "with age these vessels usually disappear, in consequence of the growth of the eye forwards and sideways and the simultaneous extension of the optic nerve. In this way the vessels become compressed; their lumen is reduced and finally obliterated." They may thus be developed in the young and atrophied in the old. (J. R. M. S., I, 18, from Arch. Mikr., Anat., xviii, 468-480, with 4 fig.)

*Development of the sturgeon.*

Prof. W. K. Parker has supplemented the important work of Salensky on the embryology of the sturgeon by a memoir "on the structure and development of the skull in sturgeons (*Acipenser ruthenus* and *A. sturio*)" in more advanced stages. It will be sufficient in this place to indicate that Professor Parker thinks that the cranial scutes of the head are only homologous to the bones of the true osseous fishes in part; that is, the teleost bones "can only correspond to the *inner layer* of the scute." But, in addition to others, "along the side of the skull in old individuals, plates of bone appear as splints or parostoses, that are manifestly the forerunners of the deeper plates that, in the higher ganoids and the telostei form the proper ectosteal bony centres of the more or less ossified cranial-box."

The discovery by Salensky of teeth in the embryonic sturgeon is, of course, confirmed. Larval sturgeons, says Professor Parker, "are, in appearance, miniature sharks. For a few weeks they have a similar mouth, and their lips and throat are beset with true teeth that are molted before calcification has fairly set in. Their first gills are very long and exposed, but not nearly so long, or for such a time uncovered, as in the embryos of sharks and skates."

*Oviposition of callichthyids.*

The fact that certain Callichthyids take care of their eggs and young, and are able to progress on land, has long been familiar through the oft-republished observations of Hancock on the so-called Hassars of Guiana. Recent experiments by M. Carbonnier, of Paris, (Comptes Rendus Acad. Sc., December 6, 1880,) furnish additional details. The individuals experimented with were received at Paris from the Rio de la

Plata. When the female is preparing to deposit her eggs, she brings together the ventral fins so as to form a pouch which receives them by degrees, and wherein they are fertilized by the males. The eggs are then deposited in a spot cleaned, by the mouth of the mother, of vegetation. Somewhere about two hundred and fifty eggs are extruded and attached by a viscous coat which envelopes them. The young are developed and able to swim in twelve or thirteen days, but they do not reach maturity till two years after hatching. It is noteworthy that the fishes introduced into France have accommodated their oviposition to the reversed seasons, for, whereas in the Rio de la Plata they lay their eggs in October or November, those born in France matured their eggs in June.

New observations on terrestrial progression of these fishes have also been published by Mr. Joseph Manson, of Bahia, in "Science" for December 25, 1880.

*A new type of suckers.*

A characteristic family of fishes for the North American fauna is that of the suckers or Catostomidæ. Two genera, it is true, are represented in Northeastern Asia; but all the other members of this family are American, and help to impart the stamp of peculiarity to the fish fauna of the United States. Ten genera have been recognized by Jordan in his revision of the family, and these are divided into three sub-families, *Catostomina*, *Bubalichthyina*, and *Cycleptina*. To the first of these is now added, by Professor Cope, a peculiar genus, called *Lipomyzon*, the species of which had been previously confounded with *Chasmistes*. They, however, exhibit a difference, especially in dentition, the pharyngeal bones being very slender and flattened, and the teeth minute and numerous, as in the carp-suckers.

Two species are known, both from Klamath Lake, Oregon, the *L. luxatus* and *L. brevirostris*.

*Peculiar eye-like organs in physostome fishes.*

Scarcely any two organs would appear to be more unlike than the eyes of vertebrate animals and the electric organs so highly developed in certain fishes—the torpedos, gymnotus or electrical eel, and malarurus or electrical cat-fish. Nevertheless there are peculiar organs found along the sides of the body, and sometimes on other parts, of sundry pelagic and deep-sea fishes, which have been claimed, on one hand, by different naturalists to be accessory eyes, and, on the contrary, by others to be rather of the nature of electric organs. The fishes so endowed are mostly of small size and like herring or salmonids in appearance, and were formerly associated in the same family as the latter, but are now referred to several peculiar families—the scopolids, the stomiatids, the chauniodontids, and the sternoptychids. Generally the organs in question are manifested as pearl-like spots distributed in longitudinal rows along the sides near the abdomen, but they are often

likewise developed on the head, and even on the branchiostegal rays. Nearly quarter of a century ago the illustrious German histologist K  lliker had suggested that these organs were "essentially nervous, and present the nearest resemblance to the electrical organs of fishes." But this suggestion received no notice, and has only recently been resurrected by Professor Bell. In 1865 Professor Leuckart published the results of a special examination, and expressed the belief that they were accessory eyes. In 1879 Professor Ussow examined the organs anew in seven distinct generic types, and urged that they belonged to two different categories, those of some fishes being accessory eyes, while those of others were special glandular organs. The two kinds, it was claimed, were never developed in the same fish. Finally, in 1881, Professor Leydig attacked the problem and made known the results of his examinations in a special work (illustrated by ten plates), of which an abstract has been given by Prof. F. Jeffrey Bell, from which, in the absence of the original, we derive the conclusions of the Bonn professor.

The peculiar organs of the fishes under consideration are referable, according to Leydig, to three categories: (1) "Eye-like organs," (2) "mother-of-pearl-like organs," and (3) "luminous organs," but the last two are confined to the scopeli.

The eye-like organs are "saccular in form and divisible into a bulb, a neck, and an orifice, and this orifice is always directed downward." They have "an investment of brown pigment, a layer with a metallic glitter, a gray inner body, and a surrounding lymphatic space. The investment is derived from the general integument of the body, and the pigment granules are contained in the cells of the underlying connective tissue; the metallic layer consists of iridescent plates, rods, or fibres. The gray inner body is divisible into two portions, the hinder and larger of which fills the sac, while the anterior and smaller occupies the narrower neck. The striate appearance of this part" is apparently due "to the presence of a framework of connective tissue, which sends rays into or forms a network in it; into this gray part there further proceeds a nerve, the fibers of which probably come into connection with the contained cells." These organs were regarded by Ussow as having one or other of two functions, but according to Leydig there is no essential difference between them, and both must have the same function—whatever that may be.

The mother-of-pearl organs "have in all cases an outer brown investment, a metallic layer, a gelatinous internal body formed of connective tissue; they are provided with nerves and blood-vessels, and are surrounded by a lymphatic space. The metallic plates are regarded by Ussow as special cells, but Leydig looks upon them as altogether similar to the minute iridescent bodies found on the skin. The gelatinous portion is made up of delicate radiate cells, which give rise to a network, and an intermediate soft substance".

The so-called luminous organs present no essential difference of structure from the preceding.

Organs exhibiting the characteristics of these parts, it is urged, cannot be sensory, much less endowed with the function of sight. The objections to their consideration as eyes are given in detail, and of the so-called lens it is said that "it does not lie in the center, but at the edge of the mass which does duty as the vitreous body," and its histology is also antagonistic to an analogy with the lens, and, "greatest difficulty of all, the 'pupil,' the 'lens,' and the 'vitreous body' are not turned upwards to the light, but so long as the fish is swimming they look downwards into the deep; and in the case of *Chauliodus* are developed also on the membrane that lines the cavity of the mouth."

What, then, are these organs? According to Leydig, the problematic bodies "bear the closest resemblance to the electric or 'pseudo-electric' organs of other fishes, and he brings many points to strengthen his position." Different as the electric organs are in form as well as position, in all they are richly supplied with nerves; they are surrounded by a layer of connective tissue, which gives rise to a number of "alveolar" chambers filled with a gelatinous substance. Now, on comparison with these of the eye-like spots of the fishes, it is found that in this one as in the other there is "a contained mass of gelatinous tissue," and "the same net-work of connective tissue," as well as "nerve fibres of very much the same character." Still other points of resemblance are adduced, but "whether they really have the power of developing electricity is a problem that cannot yet be solved." As to their phosphorescence, it is contended that "no definite phosphorescent organ has ever yet been examined which presented any other contents than fatty or oily matter." Conceding all the postulates claimed by Professor Leydig, however, in view of the surroundings of the animals developing the organs treated of, we can scarcely avoid the belief that they have some relation to illumination. In the words of Professor Bell, "it still remains possible that these creatures add to the feeble light of great ocean depths by reflecting the light that fall on these eye-like organs," although their function as such may be a secondary development.

#### *The Pacific Coast salmon.*

The species of salmon-like salmonidæ found upon the Pacific coast of North America and its entering rivers have been unduly multiplied, and much confusion has existed as to the limits of the species. With more ample material than was enjoyed by any of their predecessors, and, above all, the privilege of seeing the fishes in their haunts, Messrs. Jordan and Gilbert have revised all the known forms and have reduced them to five species. All belong to the genus *Oncorhynchus*, which differ from the *Salmo* in the greater number of rays in the anal fin, and accessory but slight modifications of the snout. The males of all the species when running into fresh water assume an attenuated

beak-like snout, and at least most of them die and never return to the sea. These five species enjoy vernacular names, and are known as follows:

(1.) *Oncorhynchus chouicha* or *quinnat*.—Chouicha, king salmon, e'quinna, saw-kwey, Chinook salmon, Columbia River salmon, Sacramento salmon, tyee salmon, Monterey salmon, deep-water salmon, spring salmon, ek-ul-ba ("ekewan"), (fall run).

(2.) *Oncorhynchus nerka*.—Blue-back.—Krasnaya ryba, Alaska, red-fish, Idaho red-fish, sukkegh, Frazer's River salmon, roseal, oo-chooy-ha.

(3.) *Oncorhynchus kisutch*.—Silver salmon.—Kisutch, winter salmon, hoopid, skowitz, coho, bielaya ryba, o-o-wun.

(4.) *Oncorhynchus keta*.—Dog salmon.—Kayko, lekai, ktlawhy, quailock, fall salmon, o-le-a-rah. The males of all species in the fall are usually known as dog salmon, or fall salmon.

(5.) *Oncorhynchus gorbuscha*.—Hump-back.—Gorbuscha, haddo, hone, holia, lost salmon, Puget Sound salmon, dog salmon (of Alaska.)\*

Of these species the quinnat is the one that is most generally known, and is the largest and finest of all, deserving the name of king salmon which has been given to it in some places. This species occurs farther south than its congeners, and enters into the Ventura River, which is the southernmost stream of California not muddy and alkaline at its mouth.

The *O. nerka* or blue-back is the most abundant species in Frazer's River, and is the famous red-fish of Idaho.

#### *The blind fishes and congeners.*

The well known and remarkable blind fish of the Mammoth Cave of Kentucky is the representative of a peculiar family, limited, so far as has been ascertained, to the Middle and Southern United States, and known by the name of *Amblyopsids* or *Heteropygii*. The forms are related, but distantly, to the cyprinodontids, and are distinguished by the position of the anus under the throat, the very small scales of the body and the scaleless head. Much interest attaches to the family for various reasons, and it has indeed been regarded as a keystone to the theory of evolution on the one hand, or specific creation on the other, Professor Agassiz having especially insisted upon the value of the study of the type with reference to this question. We are indebted to Mr. F. W. Putnam for a revision of the family, and for good descriptions of the genera and species. By him four species were recognized belonging to three genera, namely, (1) *Amblyopsis*, with the large blind fish of the Mammoth Cave; (2) *Typhlichthys*, with a smaller blind fish inhabiting subterranean streams of Kentucky, Tennessee and Alabama, and coexisting with the large blind fish in the Mammoth Cave; and (3) *Chologaster*, with

\* Observations on the Salmon of the Pacific by David S. Jordan and Charles H. Gilbert. (Am. Nat., v. 15, pp. 177-186.)

two species—*C. cornutus* and *C. Agassizii*, the former occurring in ditches in the rice fields of South Carolina, while the latter is only known from a specimen found in a well in Lebanon, Tenn. A third species of *Ohologaster* \* has recently been added by Prof. S. A. Forbes, and was discovered in aspring at the foot of a bluff in western Union County in the southern part of Illinois. At first only one specimen was obtained and a name was deferred till more information should be obtained. Later,† seven more specimens were secured and the form has been named *Ohologaster papilliferus*. The species is especially noteworthy in that it lessens the gap between its own kind and the blind fish and answers one of the objections urged against the primitive common parentage of all the species.

### *Habits of fierasfer.*

In certain of the holothurians (known as sea-cucumbers, trepangs, &c.), living at moderate depths, fishes may be found in the interior of the body. These fishes are elongated and taper to the end of the tail, which is pointed. The name of *fierasfer* has been given to them. How they enter into the holothurians has been explained by Professor Emery. When free in the water, the fish swims head downwards with tail curved toward the back, by undulatory movements of the anal fin. Coming to a holothurian lying at the bottom of the water, it eagerly seeks the posterior aperture. Sometimes it penetrates through this head-foremost, but generally enters in a characteristic manner. By its anal aperture the holothurian expels and sucks in water. The fish, during the expulsion of the water, pushes its head into the orifice and curves its tail to one side, and then by a rapid recoil movement, introduces itself, tail-foremost, into the intestinal canal, pushing farther and farther in with every suction of its involuntary host. From the intestine it penetrates into the pulmonary passages, and thence, after their rupture, into the perivisceral space. It remains, however, near the anus, and protrudes its head, when hunger impels, in search of food. It is therefore neither a true parasite, since it does not feed on its host, nor a commensal, as it does not share the food of its host, but simply a lodger or tenant at will.

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*Pterodactyli.*

- Marsh (O. C.). Note on American Pterodactyls. *Am. Journ. Sc.*, (3,) v. 21, pp. 342, 343.)

*A new order of extinct Jurassic reptiles.*

In 1879, Prof. O. C. Marsh indicated a "new genus" of reptiles named *Cœlurus*, which he subsequently re-examined and considered to represent a "new order," most nearly related to the Dinosaurians (A. J. S. (3), xxi, 339-340); or, a little later, a "suborder" probably of the "order Dinosauria" (A. J. S. (3), xxi, 423); and later still, an "order" of the "subclass Dinosauria" (xxiii, 85). The new type is remarkable for the hollowness of the vertebræ and, the extreme lightness of those bones, "the excavations in them being more extensive than in the skeleton of any known vertebrate. There was, in fact, merely a slender framework of bone to define the form and inclosing extensive cavities." The ribs, too, of *Cœlurus* are hollow, with well-defined walls to their large cavities. The metatarsals were "very long and slender." The genus is only known from various vertebræ representing the different regions of the body, ribs, and metatarsal bones. It is inferred from these that the animal had "a large and powerful neck, a trunk of moderate size, and a very long neat tail," and it has been suggested that the posterior limbs may have been larger than the anterior. "The remains now known are all from the *Atlantosaurus* beds of the Upper Jurassic of Wyoming." The name *Cœluria* has been proposed as the ordinal designation.

*American Pterodactyles.*

The remains of Jurassic Pterodactyles found in the United States hitherto have been fragmentary. Enough has been preserved, however, to enable Professor Marsh to recognize in the Jurassic fossils species

of a peculiar genus—the *Dermodactylus montanus*. In the Cretaceous, the representatives of a group distinguished by its toothless jaws are abundant, and of such two species are described. In this paper two are described—"Pteranodon nanus," and "*Nyctodactylus gracilis*." The large *Pteranodon* first described exhibited a noteworthy peculiarity of its skeleton. "To aid the powerful wings in flight, the pectoral arch is strengthened (1) by the ankylosis of several vertebræ; (2) by the robust scapulæ articulating on opposite sides of the common neural spine of these vertebræ. This is virtually a repetition of the pelvic arch on a much larger scale." This structure was apparently not manifested in *Nyctodactylus* (A. J. S. (3), xxi, 342-343.)

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## GENERAL.

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*The coloring matter of feathers.*

The coloring matter of feathers has been subjected to an elaborate examination by Dr. C. W. Krukenberg, both by chemical and spectroscopic analyses, and three different substances have been found in the red and yellow feathers of birds, to which have been given the names *Turacin*, *Zoonerythrin*, and *Zoofuloin*.

Turacin has only been detected in the feathers of the Plantain-eaters or Musophagidæ, and more especially in their red feathers. It "gives two different absorption-spectra, according to whether it is in solution or not—a very unusual circumstance with organic pigments. A solution-spectrum has two absorption-bands, nearly coinciding in position with those of oxyhæmoglobin, from which, however, Turacin differs greatly in chemical composition, containing, as is well known, copper in abundance."

Zoonerythrin "gives a continuous spectrum."

Zoofuloin affords a spectrum "with two absorption-bands which however are not those of Turacin."

The attempts made "to extract blue, violet, and green pigments from feathers so colored have as yet been unsuccessful; and these colors may therefore depend upon optical, and not chemical, causes." (*Ibis*, (4,) v. 602-603.)

*Number of American birds.\**

In 1859 was published a catalogue of the known North American birds north of Mexico, prepared by Professor S. F. Baird, which for many years afterward was the standard authority for the nomenclature and arrangement of the species. But the numerous additions that have been made from time to time, as well as the investigations upon the affinities of the forms, have necessitated a new arrangement. In 1873 a check list of the species was published by Dr. Elliott Coues, which incorporated the forms up to that time added to the fauna. Discovery still progressed, however, and during the past year a new catalogue of all the species was prepared by Mr. Robert Ridgway, and has been issued by the Smithsonian Institution, as a "Bulletin of the United States National Museum," and a comparison of it with that of 1858 is instructive in its illustration of the tendencies of ornithologists at the two periods. The catalogue of 1859 bears the impress of the influence of Professor Agassiz and Bonaparte in the excessive differentiation of species. Since that period the comparison of birds obtained from the various portions of our wide domain has shown that nominal species concerning which there existed no doubt in the early period are connected by intermediate forms obtained from intervening stations, and consequently a number of old species have been associated together as mere varieties or "subspecies" of more comprehensive species. On the other hand, the same system of comparison has compelled ornithologists to recognize the frequent existence of such differences between forms found at widely remote regions as to warrant the introduction of the category of "subspecies" or varieties which have received trinomial names. Thus we have many old species now combined together as forms of others but with varietal differentiations; in other words, the fact that while most of the individuals are separated into two or more types of differentiation as distinct forms is indicated by their recognition as varieties, nevertheless intervening forms occur which forbid their rank as fully developed species.

Comparing the catalogues of 1859 and 1881, the number of avowed species in the former is 738, and in the latter 764, but the actual number of names, that is, forms more or less distinct, including species and subspecies, was in the catalogue of 1859 764, but in 1881 924 are rec-

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\* Ridgway (Robert). Nomenclature of North American Birds, chiefly contained in the United States National Museum. Washington, Government Printing-Office, 1881. (*Bulletin of the United States National Museum*, No. 21.)

ognized. While we have thus an increase of nominal species by only 26, the number of forms—species or subspecies—is 164 more than were known in 1859. But from the catalogue of 1859 42 names have been eliminated as synonymous with others, and 20 as extra-limital, while there are given as new species in the catalogue of 1881 127 species, and in addition thereto 89 subspecies, or a total of 226. 395 of the names of the 1859 catalogue are retained in nearly or quite the original form in the new catalogue; 89 names are changed, and 100 forms appear under different genera or subgenera, while 61 of the species of the old catalogue are degraded to the rank of races in the new. The appendix of the new catalogue is especially valuable on account of the detailed information regarding changes that have been made. In this appendix, under different categories, are enumerated:

A. "Species eliminated from the catalogue of 1859." (Syns. 42 + Extralimital 20 = 62.)

B. "Species and races described or added to the North American fauna since 1859." (Sp. 127 + S. sp. 99 = 226.)

C. "List of genera which have been added to the fauna since 1859, under which are names that have been changed since that time." (26 n. g. + 108 changes = 134.)

D. "Species included in the category which have not yet, according to the records, been actually taken within the prescribed limits." (41.)

E. "Species (chiefly palæarctic) which occur only as stragglers or visitants in Eastern North America, or which occur regularly only in Greenland and adjacent portions of the continent." (39.)

F. "Palæarctic and oceanic species occurring only in Alaska and other parts of the Pacific coast." (24.)

G. "Palæarctic species occurring both in Greenland and Alaska, but not recorded from any intermediate point of North America." (4.)

H. "Tropical American species occurring only in southern portions of the United States."

I. "Supposed valid species, described by Audubon and Wilson, which have not been since met with, and of which no specimens are known to exist in collections." (4.)

J. "List of untenable species and races of North American birds described since 1858." (35.)

K. "List of exotic species which have been attributed to North America by various authors, but apparently without sufficient evidence of their occurrence." (47.)

L. "Partial list of foreign birds which have been introduced to the United States, and those which have been captured after escape from confinement." (4 + 10 = 14.)

It may be added that the species which have been introduced with a view to their naturalization, and have been actually naturalized, are four in number, viz:

(1.) *Passer domesticus*, the too common European house sparrow.

- (2.) *Passer montanus*, the European tree sparrow.
- (3.) *Alauda arvensis*, the sky lark of Europe; and
- (4.) *Coturnix communis*, the European quail.

*Birds added to the American fauna in 1881.*

*Aestrelata gularis* (Peale). Brewster: Critical notes on a Petrel new to North America. *Bull. Nutt. Orn. Club*, 1881, p. 91. From Mount Morris, Livingston County, New York.

*Puffinus kuhlii borealis*. Cory. Description of a new species of the family Procellariidæ. *B. N. O. C.*, 1881, p. 84. From Chatham Island, Cape Cod, Massachusetts.

*Fuligula rufina*, Steph. Ridgway: On a duck new to the North American fauna. *Proc. U. S. Nat. Mus.*, Apr., 1881, p. 22-24. From "Fulton Market, New York City."

*Fulica atra*, Linn. Ridgw., l. c. From Greenland.

*Eury norhynchus pygæmus* (Linn.) Ridgw. Catal., 1881. *Bull. U. S. N. M.*, No. 21, p. 85. From Arctic coast of Alaska.

*Callipepla squamata pallida*. *Id. ibid.*, p. 72. From Rio San Pedro, Arizona.

*Buteo brachyurus*, Vieill. Ridgway: On a tropical American hawk to be added to the North American fauna. *B. N. O. C.*, 1881, p. 207. From Palatka, East Florida.

*Buteo fuliginosus*, Selater. Ridgw., l. c., p. 212. From Oyster Bay, Florida. ("Melanistic phase of *B. brachyurus*!")

*Antrostomus vociferus arizonæ*. Brewster: Notes on some birds from Arizona and New Mexico, with a description of a supposed new Whip-poor-will. *B. N. O. C.* 1881, p. 69. From Chiracahua Mountains, Arizona.

*Myiarchus Cooperi* (Kaup.). Brewster: Additions to the avifauna of the United States. *B. N. O. C.*, 1881, p. 252. From Camp Lowell, Southern Arizona.

*Polioptila californica*. Brewster: On the affinities of certain Polioptilæ, with a description of a new species. *B. N. O. C.*, 1881, p. 103. From Riverside, San Bernardino Co., California—"29. *P. melanura* Lawr." Ridw. catalog., 1880, Pr. U. S. N. M., 1880, p. 168. (Nee Lawr.),

The following species, included in Mr. Ridgway's list 1881, for the first time definitely ascertained to have been taken within the limits of United States:

*Parus meridionalis*, Sel. Brewster, l. c. From Chiracahua Mountains, Southern Arizona.

*Myiarchus Lawrencei* (Gir.). Brewster, l. c. From Santa Rita Mountains, Southern Arizona.

*Characteristics of the Archaeopterygidæ.*

Prof. O. C. Marsh embraced the opportunity, during a visit to Europe in 1881, of examining the remains of the remarkable Jurassic *Archæop-*



*teryx* hitherto discovered—the feather which originally served as the basis for the name, and two carcasses. His examination resulted in the discovery of “several characters of importance not previously determined,” viz: (1) “the presence of true teeth in position in the skull;” (2) “vertebræ biconcave;” (3) “a well ossified broad sternum;” (4) “three digits only in the manus;” (5) “pelvic bones separate;” (6) “the distal end of fibula in front of tibia;” and (7) “metatarsals separate, or imperfectly united.” These characteristics indicate, in the opinion of Professor Marsh, that we have in *Archæopteryx* “the most reptilian of birds.” The brain-cast, “although comparatively small, was like that of a bird, and not that of a Dinosaurian reptile.

Apropos of its relations, Professor Marsh found that the extremities of the Dinosaurian reptile, *Compsognathus*, evinced “a striking similarity” to those of *Archæopteryx*. “The three-clawed digits of the manus correspond closely with those of that genus, although the bones are of different proportions. The hind feet also have the same structure in both. The vertebræ however and the pelvic bones of *Compsognathus* differ materially from those of *Archæopteryx*, and the two forms are in reality widely separated.” Professor Marsh adds that “the nearest approach to birds now known would seem to be in the very small Dinosaurs from the American Jurassic. In some of these the separate bones of the skeleton cannot be distinguished with certainty from those of Jurassic birds, if the skull is wanting, and even in this part the resemblance is striking.” (A. J. S. (3), XXI, 337–340.)

#### *An American Jurassic bird.*

Although the famous *Archæopteryx lithographicus* testified many years ago to the existence of birds in the Jurassic period in Europe, no remains of the class had been found in America older than Cretaceous. But Professor Marsh's search for more ancient forms has been lately rewarded “by the discovery of various remains, some of which are sufficiently characteristic for determination.” The posterior part of a skull exhibited characters which have served as the basis of the “*Laopteryx priscus*, gen. et sp. nov.” The size indicated “a bird rather smaller than a Blue Heron.” In its main features, “it resembles the skull of the *Ratitæ* more than that of any existing birds.” In the “matrix attached to this skull a single tooth was found, which most resembles the teeth of birds, especially those of *Ichthyornis*. It is probable that *Laopteryx* possessed teeth, and also biconcave vertebræ.” The skull described “and others apparently of the same species, were found in the upper Jurassic of Wyoming Territory in the horizon of the *Atlantosaurus* beds.” The discovery thus signalized is one of great interest on account of its establishing practically (what was of course theoretically certain) the existence of birds in the Jurassic period, and as a presage of future discovery. The specimen found was not however sufficient to enable Professor Marsh to give a diagnosis which does more than

prove that the form indicated was a generalized bird. For a knowledge of its peculiar characteristics and affinities we must await the exhumation of other specimens (A. J. S. (3), xxi, 341-342).

*Shedding of the gizzard lining by birds.*

It has for some years (since 1869) been known that the horn-bills (Bucerotids) shed the epithelial lining of the gizzard, but it is only lately that the same peculiarity has been observed in very different birds. Mr. A. D. Bartlett, the superintendent of the Gardens of the Zoological Society, ascertained that a darter (*Plotus anhinga*) had "thrown up the lining of its stomach on three or four occasions," during the latter half of 1880. A casting was examined by Mr. W. A. Forbes, the prosector to the society, and was found to be "undoubtedly the shed 'epithelial' coat of the gizzard," and on microscopical examination proved to be "quite identical in structure with that of the unshed epithelium of the stomach." Mr. Bartlett thinks that a similar habit will be found to occur in other birds, and suggests that the cormorants especially may manifest it. (P. Z. S., 1881, 247-248.)

*A claw on index digits of the turkey vultures.*

Dr. Shufeldt has called special attention to the development of a large claw on the index digit of the turkey vulture and related forms of the Cathartidæ. In a young California vulture or condor (*Pseudogryphus californianus*) the claw was over a centimeter long. "It can be immediately brought into view and examined by simply parting the feathers that overlie the region of the first finger, whereupon it will be found to be a strong curved claw—convex anteriorly, sharp, slightly grooved from above downward on its posterior aspect, covered by the same kind of horny integument, or thecæ, that shields the bony claws of the feet, and movable." When the horny sheath is removed, "it leaves an osseous claw, such as we find in the distal or ungual points of the feet; this has a transverse facet at its base, that articulates with a similarly placed surface at the extremity of the index digit, rather toward its outer side." Numerous Old World vultures and other Falconidæ were re-examined with reference to the question, and no corresponding claw was found in any species. It was consequently suggested that its development in Cathartidæ may be looked upon as a family characteristic. The claw has however been since found in true Falconidæ.

*Woodpeckers and moth cocoons.\**

Premising that one of the most interesting, as well as difficult problems in entomology is the relation which the cocoon sustains to the pupa, and the various ways in which the cocoon offers protection to the pupa, or future imago, Mr. Webster has regarded the attack of the

\* *Cecropia* cocoons punctured by the hairy Woodpecker. By F. M. Webster. Am. Nat., v. 15, pp. 241, 242.

hairy woodpecker on the cocoon of the large cecropia moth ; in opposition to the belief that the cocoons offer protection against other natural destructive agencies, such as mice and birds, it is remarked that "there is at least one bird, the hairy woodpecker (*Picus villosus* Linn.), from whose attack the staunch cocoon of the cecropia offers no protection whatever." Indeed, although, so far as Mr. Webster was able to observe, birds do not attack these cocoons at all until winter ; they then seem to make it a regular source of subsistence, and where the woodpecker abounds the cocoons are rarely left uninjured. We need only remark, in this connection, that while the observations of Mr. Webster may be quite correct, his inference is scarcely justifiable, at least to the extent he would seem to push it. What dangers the cocoon may escape because of its envelopment are unknown, but, doubtless, more than offset those noticed by Mr. Webster.

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*Development of the ear-ossicles.*

As is generally known, the principal auditory ossicles of mammals are represented by external bones in the inferior vertebrates, but it seems to be yet a question what are the exact equivalents in several cases. The English anatomists—notably Huxley and Parker—have latterly maintained that (1) the *malleus* is developed from the first branchial arch in connection with Meckel's cartilage, while (2) the *stapes* and *incus* are derived from the second or hyoidean arch. This view has now been called into question by Prof. W. Salensky. That embryologist instituted researches on the development of the ossicles in embryonic lambs and pigs ranging from 1.5 centimeters long upward, and derived the following conclusions:

A 1. "The proximal segment, at an early period separated from the cartilage of the first visceral arch, becomes the rudimentary *incus*. (The second visceral, Reichert's cartilage, here plays no part.)"

A 2. "The distal moiety of the same cartilage gives rise to Meckel's cartilage (*s. str.*), together with the rudiment of the *malleus*."

B 1. "The *stapes* is formed independently of the other auditory ossicles."

B 2. "It begins as an accumulation of cells around the mandibular artery."

B 3. "From its first appearance the *stapes* is a perforate and not a solid plate, though wrongly taken for the latter by all embryologists." (J. R. M. S., I, 18-19, from Morph. Jahrb., VI, 415-432, with pl.)

In fine, Salensky adopts the old view propounded by Reichert, and which was also originally accepted by Huxley.

*New Jurassic Mammals.*

In the report of the Smithsonian Institution for 1880, a list of the Jurassic mammals, found up to 1880, was given and thirteen species were therein enumerated. During 1881, Professor Marsh added to the list four more, two of them representing distinct genera, viz: *Alloдон laticeps* and *Docodon strigatus*. Professor Marsh believed that the former should probably be placed in the *Plagiaulacidae* and that the latter was most nearly allied to *Diplocynodon*. The other species were named *Ctenacodon nanus* and *Dryolestes gracilis*. As usual for Jurassic mammals, only lower jaws of the several species were found. All were obtained

from the upper Jurassic beds of Wyoming Territory. (A. J. S. (3), xxi, 511-513).

*The Development of the Placenta and its Classificatory Value.*

Many, or rather most naturalists for the past two decades, have attached a primary value to the modifications under which the placenta is manifested, for the classification of mammals. This question was re-examined early in 1881 by Dr. F. M. Balfour. He considered that "the fact that in marsupials both the yolk-sac and the allantois are concerned in rendering the chorion vascular, makes it *à priori* probable that this was the case in the primitive types of the placentalia; and this deduction is supported by the fact that in the rodentia, insectivora, and cheiroptera this peculiarity of the foetal membranes is actually found." In the primitive placentalia it is also probable that, from the discoidal allantoic region of the chorion simple foetal villi, like those of the pig, projected into uterine crypts; but it is not certain how far the umbilical region of the chorion, which was no doubt vascular, may have also been villous. From such a primitive type of foetal membranes divergencies in various directions have given rise to the types of foetal membranes found at the present day."

Reference must be had to Professor Balfour's article for his views as to the further development of the placenta, the ways in which modifications have arisen, and the significance of such modifications. It can only be added in this place that his conclusions are as follows: (1) The rodents, insectivores, and cheiropters exemplify the closest approach to "the primitive type of placenta described above" and departed least from what are called the "protoplacentalia"; (2) the lemuroids, the ungulates, and the edentates, or rather their ancestors, "must have branched off from the primitive stock before the preceding had become distinctly differentiated"; and (3) the primates "are to be derived from a primitive lemurian type." But as to the edentates and ungulates it is a question "how far these groups arose quite independently from the primitive stock, or whether they may have had a nearer common ancestor." The carnivores were "certainly an off-shoot from the primitive placental type which was quite independent" of the lemuroids, ungulates, and edentates, but at what stage cannot be determined. "No important light is thrown by the placenta on the affinities" of the proboscideans, cetaceans, or sirenians, but it was thought that "the character of the placenta in the latter group favors the view of their being related to the ungulata." The recorder feels impelled to add that it seems scarcely probable that the cetaceans and sirenians have diverged from different primitive stocks. (P. Z. S., 1881, 210-212.)

*Relations of some Marsupials.*

From analogy in the placental mammals much weight has been attached to some of the modifications of the dentition observable among

the marsupials. The wombats (*Phascolomys*) of Australia, for example, have rodent-like incisor teeth, and have been generally regarded as representatives of quite a peculiar family. Mr. A. M. Forbes, after a special examination of the koala (*Phascolarctas*) and collaterally of other forms, came to a different conclusion, and has proposed to combine the wombats, the koala, and the phalangers in one family, or at least group of families, of which the several types named may in the former case constitute subfamilies. The common characters of the three forms combined under the name *Phalangistidae* are a "diprotodont marsupialia, with clavicles, and not more than six incisors above the hallux present, the second and third digits of the pes smaller than the others, and more or less united together by integument; stomach not sacculated; cæcum present; glans penis more or less bilobed; vaginae provided with median *culs-de-sac* which may unite." The phalangers (5 genera) constitute the subfamily (1) *Phalangistivæ*; the koala the subfamily (2) *Phascolarctinæ*, and (3) the wombats the subfamily (3) *Phascolomyinæ*.<sup>1</sup> (P. Z. S., 1881, 180-195.)

*On the structure of the pharynx, larynx, and hyoid bones in the Epomophori.*

"In all species of Chiroptera of which the structure of the pharynx and larynx has hitherto been described, and in all of those examined up to the present by [Dr. Dobson], the form of these parts has been found remarkably simple, differing but slightly from that of the insectivora, all agreeing in possessing a short pharynx generally guarded by a short acutely-pointed epiglottis, which, in some genera (*Harpyia*, *Vampyrus*, e. g.), is almost obsolete, opening close behind the fauces, near to which also the posterior nares enter, and in the small size of the laryngeal cavity and feeble development of the vocal chords, the hyoid bone also being slender and connected by a chain of simple cylindrical bones with the cranium.

"In the *Epomophori*, however, we find in the structure of all these parts a remarkable departure from the general type; the pharynx is long and very capacious, the aperture of the larynx far removed from the fauces; and opposite to it a canal leading from the nasal chambers and extending along the back of the pharynx opens; the laryngeal cavity is spacious, and its walls are ossified, and the vocal chords are well developed; the hyoid bone is quite unconnected, except by muscle, with the cranium; the ceratohyals and epihyals are cartilaginous and greatly expanded, entering into the formation of the walls of the pharynx, and, in the males of two species at least, supporting the orifices of the large posterior pair of air-sacs which extend beneath the integument of the sides of the neck."

Dr. Dobson then proceeds to describe the structures exemplified in the *Epomophorus fraqueti* in detail, and finally considers the physiology of the modified parts in the following terms:

"The remarkable form of the hyoid bones and great development of the isthmus faucium part of the pharynx, in which (though especially



pronounced in the males of certain species) all the species agree, may be understood when we consider the nature of the food of these animals.

"In the collection of the British Museum are specimens of *E. gambianus* from the banks of the Zambesi, with the note "eating figs" on the label attached to them by the donor Dr. Kirk. That figs constitute the food of *E. franqueti*, *macrocephalus*, *labiatus*, and *minor* also I have proved by finding remains of these fruits in the alimentary canal of these species.

"The fig being a hollow receptacle containing numerous small fruits, is not easily detached from the branch for the purpose of mastication; and its outer rind is evidently too tough to be readily torn through by the feeble teeth of the *Epomophori*. The easiest method therefore of getting at its soft juicy contents is by sucking them out through the aperture at the distal extremity of the fig.

"Now the whole structure of the mouth and pharynx of these animals is admirably suited for this purpose. The peculiarly voluminous lips are capable of completely encircling the fig, and their adherence to its smooth surface is evidently securely maintained by the soft pads which spring from their upper margins near the angles of the mouth. While thus encircled by the lips, the fruit is probably slowly chewed by the feeble acutely pointed teeth, and pressed upwards against the prominent palate-ridges so as to cause it to give up more freely its juices and soft contents which are drawn out by suction through the terminal aperture.

"The construction of the parts above described is specially suited to the action of suction, accomplished probably by the alternate action of the buccal muscles and the lungs. The spacious pharynx, shut off from the nasal apertures by the constrictors of the pharynx, and from the mouth by the small valvular opening referred to, and having its sides supported behind by the expanded hyoid bones, constitutes a most perfect exhaustor; while the broad epiglottis, permanently folded over the larynx in front so that its aperture is directed upwards towards the spine, and the great size of the fibro-cartilaginous masses extending forwards from the arytenoid cartilages to the epiglottis, effectually guard the glottis, preventing any part of the food, such as the small fig-seeds, from being drawn into the air-passages."

#### *American Miocene rodents.\**

Professor Cope has studied the American miocene rodents, and given a list of all the known species. Not less than thirty-seven have been recognized, and these are referred to 17 genera and distributed under 9 families.

The sciuridæ, ischyomydæ, castoridæ, mylagaulidæ, an undetermined one for the genus *heliscomys*, muridæ, geomyidæ, hystricidæ, and lep-

\* Cope, E. D. The Rodentia of the American Miocene. Am. Nat., v 15, pp. 586, 587.

oridæ were all represented by species. Most of these families will be recognized as still existent, but two or three families are only represented by extinct forms, viz: ischyromyidæ, mylagaulidæ, and perhaps the *heliscomys* type.

*Use as a factor in the differentiation of ungulate animals.*

Professor Cope, following out the line of investigation indicated in this country by Mr. John A. Ryder and Professor Cope himself, seeks to show that the distinction between the odd and even toed types of ungulates is due, in great part, to the effect of use of the toes in progression. He recalls that the principal specializations in the ungulates are as follows:\*

1. "The reduction of the number of toes to one in the Perissodactyla (horses, etc.), and two in the Artiodactyla (cloven feet).
2. "The second hinge-joint in the tarsus of the Artiodactyla.
3. "The trochlear ridges and keels of the various movable articulations of the limbs," whether looking downwards (5 categories) or looking upwards (4 categories).

It is insisted upon that the trochlear keels that look downwards are much the most prominent and important. The others, enumerated as looking forward, are weak and insignificant, or of a different character from the down-looking ones. "The latter are all projections from the middles of the ends of the respective elements. The up-looking are generally projections of the edges of the bones. Such are the lateral crests of the astragalus and the adjacent edges of the cuboid and navicular bones, which cause the emargination of the astragalus in the Artiodactyla. The proximal ridges of the phalanges are very weak, and the concavities in the extremity of the radius cannot be called trochlear, as they are adaptations to the carpal bones."

Professor Cope then comes to the following conclusions:

1. "The reduction in the number of toes is supposed to be due to the elongation of those which slightly exceeded the others in length, in consequence of the greater number of strains and impacts received by them in rapid progression, and the complementary loss of material available for the growth of the smaller ones."

2. "The hinge between the first and second series of tarsal bones in the Artiodactyla may be accounted for by reference to the habits which are supposed to have caused the cloven-footed character. Observation on an animal of this order moving in mud shows that there is a great strain anteroposteriorly transverse to the long axis of the foot, which would readily cause a gradual loosening of an articulation."

3. "The trochleæ. These prominences, which form the tongues of the tongue and groove articulations, exhibit various degrees of development in the different mammalia, and those of different parts of the

\* COPE (E. D.) On the effects of Impacts and Strains on the feet of Mammalia. *Am. Nat.*, v. 15, pp. 542-548.

skeleton coincide in their condition in any one type of ambulatory mammalia, and so may well be considered together. This fact suggests strongly that they are all due to a common cause."

Of the prominences in question, it is added that "they are all imperfect in the rodentia and carnivora (except the leporidæ), which are especially characterized by their great speed. Among ungulates they are very imperfect in the proboscidea. The orders mentioned all have elastic pads on the under side of their feet or toes. The same is true of the lowest types of both the artiodactyla and perissodactyla, the hippopotami and rhinoceroses. In the ruminantia the trochleæ are well developed, with one exception, and that is the distal metacarpal and metatarsal keels of the camelidæ. These animals confirm the probability of the keels being the effect of long-continued shocks, for they are the only ruminants which have elastic pads on the inferior sides of their digits."

*A New type of ungulates.*

Through the investigations of Professor Cope there has been discovered, in the Wasatch Eocene of Wyoming, a new type of mammal, which, while related to the ordinary perissodactyles, or odd-toed ungulates, presents certain peculiarities which necessitate its differentiation from the existing type. The newly discovered type approaches the proboscideans, and differs from the perissodactyls in the fact that the astragalus articulates with the navicular only, and by a universal convex surface, as in the carnivores.

The new type realizes the prediction long before ventured as to the development of five good-sized toes on all the feet. "The cast of the brain case shows that the cerebral hemispheres were quite small and nearly smooth, and that the very large cerebellum and olfactory lobes were entirely uncovered by them. The bones of the two carpal rows alternate with each other, and there is a large third trochanter of the femur." The animal is supposed to have been partially plantigrade. It was at first regarded by Professor Cope as a suborder of perissodactyla, and named *Condylarthra*, and diagnosed by the "astragalus convex in all directions distally, only uniting with navicular bone, a third trochanter of femur." Recently, however, it has been elevated to ordinal distinction.

In addition to the typical genus, named *Phenacodus*, a number of forms coeval with it have also since been associated with it as members of the same group.

# ANTHROPOLOGY.

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BY OTIS T. MASON.

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## INTRODUCTION.

The word progress as applied to any science may mean either additions to our knowledge, without inquiry into their value or relations, or it may imply improvement in the quality of material, the instrumentality of research, or in the significance of results. Our account of the progress of anthropology during 1881 will embrace all the particulars above named. Not only have students gone on amassing materials and facts from old mines, but they have opened up new leads, as classes of phenomena hitherto regarded desultory have shown themselves to be the results of fixed laws.

As in former summaries, the materials are arranged according to a classification which has been adopted more for the convenience of special students than because it embodies all the facts according to well defined bases of division. And yet the arrangement is not wholly unphilosophical. Whatever the time, the place, the manner, or the condition, the human race had an origin upon our globe. For the discussion of such questions Haeckel uses the term ANTHROPOGENY.

After this event, came long periods of struggle from the lowest savagery up to the time when the peoples of the earth could record their own history. The record of these epochs is indicated only by a few human remains, and the implements of activity. The study of these remains and their relation to time is called ARCHÆOLOGY.

The exclusion of the past leaves us the present and the future. As he stands before us now, man is an animal, epitomizing in his embryonic growth the history of all faunas, and exhibiting in his adult form those characteristics which engage the attention of the anatomist, the physiologist, and the anthropometer. To this extensive study, the old anthropology, so brilliantly pursued by Paul Broca and his school, and so sadly neglected in America since the death of Jeffries Wyman, we may apply the term ANTHROPO-BIOLOGY, or the biology of man.

Again, we find this being endowed with a set of faculties called intellectual, allied in certain particulars to those of the lower animals, but so far transcending them as to form a separate branch of study, requiring totally diverse methods and machinery of observation, and enlisting an entirely different set of investigators. To all these studies we have given the name of COMPARATIVE PSYCHOLOGY, or PHRENOLOGY.

Through causes now under investigation the human family has become differentiated anatomically, and these variations have been more or less fixed and intensified by social and national prejudices, until there have arisen races of men. The description of mankind, race by race, may be called **ETHNOGRAPHY**. All discussions concerning race and the causes leading to race distinctions should be named **ETHNOLOGY**.

Among the characteristics of these diversities of man the most trenchant, useful, and prominent is language. The investigations respecting the origin and the diversity of languages we name **GLOSSOLOGY**, though the terms **LINGUISTICS** and **COMPARATIVE PHILOLOGY**, have some claims to preeminence in the matter.

Next to the speaking tongue comes the cunning hand. Indeed, the footprints of civilization during its toilsome march may be traced better through handicraft in the various human occupations than in any other way. To this study Klemm gave the name *Culturgeschichte*, but the title preferred here is **COMPARATIVE TECHNOLOGY**.

For regulating the propagation of the species, the care of the young, the division of labor, and for mutual protection there exist everywhere (1) traditional or written codes, (2) manners and customs, and (3) instrumentalities. For the investigation of these matters the term **SOCIOLOGY** is used.

All races of men have beliefs, practices, and organizations with reference to a world of spirits. To call the study of these things comparative religion would be misleading. For, in the first place, the word implies action rather than study, and, in the second place, it is commonly understood to refer only to the higher forms of worship. Various terms have been suggested, as comparative mythology, spiritology, pneumatology, philosophy, daimonology, &c. Although the term "daimonology" was used in the last summary, in order to call forth the opinions of those competent to judge, the word **PNEUMATOLOGY** is here employed with some reserve for the same purpose.

The human race, like all other groups of living beings, is surrounded and transfused by the laws of the material environment. As the bottle is the joint product of the breath of the glass-blower and the mold, so are the tribes of men the result of their own inherent vitality and the environment. The behavior of living beings in the presence of their environment Mr. Mivart has called **Hexicology**, for which the more properly-constructed and more euphonious term **HEXIOLOGY** will here be employed.

Finally, anthropology, like every other honest craft, must have its tools and its workshops, viz, its museums, libraries, societies, journals, and implements, and its encyclopedic works. For all these the term **INSTRUMENTALITIES OF RESEARCH** will be used. The scheme, therefore, stands:

1. Anthropogeny.
2. Archæology.
3. Biology of man.

4. Comparative psychology or phrenology.
5. Ethnology.
6. Glossology.
7. Comparative technology.
8. Sociology.
9. Daimonology or pneumatology.
10. Hexiology.
11. Instrumentalities of research.

It is well known to all students of nature that knowledge passes through three stages. The first is the observing and *descriptive* stage, in which the universe is explored for new materials and facts. The second is the inductive and classifying stage in which facts and materials are arranged according to differing bases and general *principles* arrived at. The third is the deductive or predictive stage, the true scientific step, in which the *laws* and the true nature of things are ascertained with such accuracy that new consequences may be deduced, and the recurrence of phenomena, under certain circumstances, may be predicted. A scheme of nomenclature is presented below merely as a suggestion, in order to ascertain the opinion of anthropologists as to its merits. To represent the three stages mentioned above, the Greek words *γράφη*, *λόγος*, and *νόμος* are chosen to furnish the significant termination, agreeably to established analogy. As will be seen, a difficulty occurs with psychology and phrenology, and with the terms denoting the spirit world together with the actions and apparatus growing out of it. These difficulties have been noticed under the appropriate head.

As the genesis or origin of anything is essentially speculative, however necessary, the first term of our technical series does not admit of this tripartite division :

Anthropogeny (undifferentiated.)\*

Observing and descriptive stage. (γράφη)	Inductive and classifying stage. (λόγος)	Deductive and predictive stage. (νόμος)
Anthropography .....	Anthropology .....	Anthroponomy.
Archæography .....	Archæology .....	Archæonomy.
Biography .....	Biology .....	Bionomy.
{ Psychography .....	{ Psychology .....	{ Psychonomy.
{ Phrenography .....	{ Phrenology .....	{ Phrenonomy.
Ethnography .....	Ethnology .....	Ethnonomy.
Glossography .....	Glossology .....	Glossonomy.
Technography .....	Technology .....	Technonomy.
Sociography .....	Sociology .....	Socionomy.
{ Pneumatography .....	{ Pneumatology .....	{ Pneumatonomy.
{ Daimonography .....	{ Daimonology .....	{ Daimononomy.
{ Mythography .....	{ Mythology .....	{ Mythonomy.
Hexiography .....	Hexiology .....	Hexionomy.

Instrumentalities of Research (undifferentiated).

\*By a further application of the Greek word *γενεα*, this term might be used in a generic sense as the beginning of a quaternary division, making the series—anthropogeny, anthropography, anthropology, anthroponomy; thus giving four columns instead of three; the first of which would embrace the genesis of those branches in which the question of origin could arise.

The multiplication of works on anthropology throughout the world makes it absolutely impossible to even name them within the limits of this summary. It is designed to mention only works on America, works by Americans, and valuable republications in America of foreign productions. In addition to this, the names of foreign journals, &c., containing anthropologic bibliographies will be given among instrumentalities. In this manner the student will have the means of compassing the whole field of literature relating to the science.

In order to render this summary more complete from year to year the co-operation of all American anthropologists is earnestly solicited.

#### I.—ANTHROPOGENY.

The question of man's origin is separable into several subdivisions, related among themselves, but quite distinct. Among the titles quoted under anthropogeny will be noted some referring to the time of man's advent and its connection with geology, others dealing with the evolution of man and his relation to the animal kingdom. A third group discuss the origin and development of parts of his organism, as the brain, the soul, or the sexes. A fourth class is concerned with the bearing of the question upon the Adamic races of Genesis. Finally, Dr. Woodward, in his annual address before the Washington Philosophical Society, examines the modern conceptions of the mechanical nature of life, and puts in a plea for the existence of a vital force. The subject is surrounded with so many difficulties that men of true scientific aspirations have declined to spend much time speculating about it, when so much valuable material lay within their grasp untouched.

#### II.—ARCHÆOLOGY.

There is not a State in our Union devoid of interest to the archæologist. Along the entire border touched by the salt water are the shell-heaps. Inland upon the Atlantic border occur stone implements as surface finds in great variety, and rude celts are found in the river gravels. Once upon the streams flowing westward into the Mississippi the student of the past is among the mounds and earthworks of a higher group of peoples. The same character of remains also occur in the Gulf States and through the first tier west of the Mississippi River.

As yet the Plains of the Great West, the Great Interior Basin, and the Sierras have yielded few evidences of ancient population, excepting in the west coast shell-heaps and in the so-called relics from the auriferous gravels of California. In New Mexico and Arizona the past is continued to the present in the pueblos, cliff-dwellings (both cavated and walled), the deserted pueblos, and in the relics of former industry. Further south there remain throughout Mexico many ruins of the former populations even yet unexplored.

It is difficult to report all that is doing for the study of every portion of our Territory. The popularity of archæology induces many persons

of wealth or leisure to expend much time and money on private collections. The committee of arrangements of the American association last summer published a list of all such private museums in and around Cincinnati. The public enterprises for the exploration of American antiquities demand a more than passing notice. In Massachusetts, the Archæological Institute of America in Boston, the Peabody Museum in Cambridge, and the Antiquarian Society of Worcester are doing most valuable service to archæology. The first named has secured the services of Mr. A. F. Bandelier among the pueblos, and has published its first volume noticed in the bibliography of archæology. The report of the Peabody Museum for 1881 has not yet appeared, but a reference to the names of the curator and his assistants will show that they have not been idle.

No publications in archæology have been issued by the museum in New York or the societies of Philadelphia. The Smithsonian Institution has published its annual report and Vol. XXII of Contributions, which includes the monographs of Jones, Habel, Rau, and Dall, previously issued in separate form. The Bureau of Ethnology, though devoted mainly to language, sociology, and mythology, has employed two explorers among western mounds, and under its auspices Col. James Stevenson, with a competent force, has been occupied in the pueblo country reaping a rich harvest of ancient and modern pottery and other objects. The bureau has also issued as a part of Vol. V, "Observations on cup-shaped and other lapidarian sculptures in the Old World and in America," by Charles Rau.

Mention should also be made of the Lorillard expedition to Mexico and Central America under M. Désiré Charnay, whose preliminary reports have appeared in the pages of the *North American Review*.

In the State of Ohio, the Western Reserve and Northern Ohio Historical Society publishes tracts, and the Madisonville Literary and Scientific Society, associated with the Cincinnati Society of Natural History, reports the progress of explorations in the Madisonville Cemetery.

In the State Historical Society and in the Geological Survey volumes of Indiana, Wisconsin, and Minnesota occur, now and then, accounts of ancient remains.

The papers on archæology at the American association will be found enumerated under Instrumentalities. Special volumes upon archæology will be noticed under the names of Abbott, Bransford, Evans, Geikie, Merrill, Nadaillac, Putnam, Rau, Reiss, and Wheeler.

### III.—BIOLOGY OF MAN.

It is much to be regretted that we have not on the western continent an institution for the study of man as a member of the animal kingdom. For this cause that portion of anthropology, which has been pursued with such brilliancy in France, England, Germany, Russia, and



Italy, has almost languished among us. Exception must be made in favor of those surgeons who have, in their medical college courses, introduced higher studies, and those geologists who sought to complete their investigations by including the highest member of the vertebrate branch. A further exception in favor of special laboratory work should be made in favor of the cranial measurements prosecuted at the Peabody Museum, by Mr. Lucien Carr, and at the Army Medical Museum, Washington, by Mr. Parker, under the direction of the late Dr. Otis. The last-named institution published the second volume of its great index-catalogue of medical literature, which includes many titles on the biology of man. Dr. Billings and Dr. Fletcher continue the editing of the *Index Medicus*, a monthly, devoted to the cataloguing of periodical medical literature.

#### IV.—PSYCHOLOGY OR PHRENOLOGY.

As interpreted by Professor Huxley, biology includes thinking and the emotions, as well as mere animal and vegetable life. As long, however, as we separate the two things for the subject of investigation, it is necessary to distinguish them by proper names. The term "psychology" has become somewhat popular, but, as expressing an inductive science of mind or intelligence, is less appropriate than the term "phrenology." The objection to the use of the latter word is that it was formed and first employed by Dr. Gall to express a theory of mind and character based on the observation of the external form of the skull, and that it has ever since been thus exclusively applied. This system, however, by reason of its immature and faulty inductions, has so far fallen out of use and sight by the scientific explorer in the field of mind, that it may be regarded as obsolescent, if it is not indeed extinct. To suffer the name, which would naturally have been selected for the latter science, to perish with the earlier and abandoned scaffolding, would seem to be unnecessary and unwise. The term "biologize," applied by a class of peripatetic exhibitors to express their manipulations, has not prevented "biology" from being completely redeemed. Indeed the analogous term "psycologize" has had a similar career; nor has the previous use of "anthropology," in a theologic sense, debarred its employment to comprehend the entire study of the natural history of man. Is there any good reason, therefore, why an effort should not be made to rescue the abused but expressive term "phrenology" from its impending fate for service in a broader and sounder department of investigation?

The phrenology or psychology of man may be and is considered from various points of view. James and Romanes approach the subject from the side of the reasoning powers of animals. Spitzka and Varigny would reconstruct a phrenology upon the results of cranio-cerebral topography. Preyer and Wyma watch the unfolding of the infant mind. Mason observes the mental condition and changes of savages in the presence of higher civilization. Professor Porter seeks to discover in-

tellection and mental growth aside from the medium of language. In all these studies there is real progress. No doubt introspection reveals to a trained thinker the processes of thought; but the careful observation of many minds—animal, infantile, savage, and civilized—in their processes, sequences, and aims will disclose results hitherto unexpected.

#### V.—ETHNOLOGY.

The great mass of our ethnologic literature is ethnographic. Little has been attempted within a year towards developing a rational scheme of humanity on indisputable marks. Under the encouragement and patronage of anthropological associations trained observers bring us into intimate acquaintance with our brethren of every clime and grade. The bibliographic list attached to this paper includes descriptions of the peoples of the two Americas, tribes of the Eastern Continent visited by Americans, and even ethnologic reprints which have been brought out by our American publishers. Prof. John Campbell, of Montreal, attempts on philologic grounds to trace the relationships of the American Indians. Major Powell's first annual report gives notice of a synonymy of all tribes ever known to have inhabited North America, together with their priscan home, migrations, and linguistic affinities.

#### VI.—GLOSSOLOGY.

In glossology our country has much that is attractive and of permanent value to offer. In the first place, grammars and dictionaries of all our tribes are in the course of preparation, not only by missionaries, both Catholic and Protestant, but on a larger scale by the Bureau of Ethnology, and even by foreign societies. Again, the meaning of the word language has come to be better understood through studies on America. The whole panorama of the growth of organized writing, or speech to the eye, may be witnessed by the pictographs and aerial pictures, called sign language. It may not be that we shall ever understand the Maya hieroglyphics; but the investigations of Mallery, Thomas, Holden, and others on the same line will exhibit to us the value of each form as parts of a continually improving series.

#### VII.—COMPARATIVE TECHNOLOGY.

Whether we originate or whether we borrow the materials, implements, processes, and products of industry, the history of civilization cannot omit the arts, by whomsoever elaborated or practiced. The list of publications noticed is very meager, and does not at all represent the immense amount of literature which accumulates upon this subject. The new National Museum will be anthropological, and all the objects there will be arranged with reference to the evolution of human industry. A hurried visit through our Patent Office, or, indeed, the inspection of any old garret or farm yard will convince one of the rapidity with which the fertile genius of man adapts itself to changing environment.

Just here a word of caution may not go amiss. Collectors of objects for anthropological museums should be careful to note with reference to each specimen the source of the material, all the tools employed in its elaboration, the caste or sex to which its use is relegated, the time or season of the manufacture, the craft processes and the ceremonies observed, the variety and range of products in fineness, form and function.

#### VIII.—SOCIOLOGY.

The term "sociology" as a philologic hybrid is not entirely satisfactory, but it could not now be easily displaced, nor is it indeed easy to substitute a better word. The summary of progress in anthropology each year exhibits a gratifying progress in sociology. The recognition of the oneness of all human phenomena gives value to the social structure of even the lowest tribes. We seem to hear in the songs and dances of the savage Indians the echoes of our own priscan history. Our own Bureau of Ethnology is not behind in this matter. Major Powell has worked out the Wyandotte scheme, and has elaborated a series of charts by means of which the clan and the family organization of any people may be exhibited.

The inspection of the list of works will show how these investigations have ramified into every department of society, including marriage and family life, tribal structure and functions, political institutions, acquisition, tenure, and cession of property, fashions, economics, statistics, education, disease, crime, and death.

#### IX.—DAIMONOLOGY, OR PNEUMATOLOGY.

It is easier to indicate what is included in this class than to find a name. As regards any set of human activities we have to inquire by whom, with what, and how. It may be the making of a pot. If so, then society is organized into those who make and those for whom they make. Again, the clay must be taken from a certain place at a certain time, and with appropriate ceremonies; the effect depending quite as much upon the method as upon the material or the implement. Further, more, there are certain tools useful to the potter only; and finally the finished product of his art passes on to be the implement of some other craft, say the water seller, the cook, or the caterer.

Now, if we desire to study the religions of the world we must have a museum containing models of typical sacred inclosures or edifices, together with all the furniture belonging thereto. This will not suffice; we must have mannikins dressed to resemble all the servitors in these temples, let us call them. Even that would be dead religion. For these figures must move, they must go through every performance which enters into their ritual and liturgy, observing carefully the right posture, saying the right words, at the proper time of the day, or of the month, or of the year. After all this would be more interesting than com-

prehensible, for we should know what words they utter, what their own conceptions and motives were, and on what general law their conduct is based. We should not be long in finding out that all we had seen had reference to a supra-sensible world. The investigation which we are engaged in, therefore, is the study of human beliefs, of social organizations, activities, instrumentalities, with reference to the supra-sensible, the so-called spirit world. Inasmuch as we have borrowed a specific term from the theologians to stand for the whole study of man, we may be compelled to take the word pneumatology, meaning with them the doctrine of the Holy Spirit, for the science of the spirit world.

#### X.—HEXIOLOGY.

Professor Mivart, in his monograph upon *the cat*, devotes a chapter to the hexicology (hexiology?) of the animal. "Every living creature has also relations with other living creatures, which may tend to destroy it, or indirectly to aid it, and the various physical forces and conditions exercise their several influences upon it. The study of all these complex relations to time, space, physical forces, other organisms, and to surrounding conditions generally, constitutes the science of hexicology (hexiology?). The higher a plant or animal stands in its kingdom the greater will be the variety of influences bearing upon it and the greater will be the diversity of impressions made by any external agent. This being true, the relations of man to force and to matter in the three kingdoms of nature would be numerous and complicated. Indeed it is only within our own day that men have conceived the possibility of grappling with this subject at all; and even now treatises upon the subject are so scattered and so mixed up with economics and medicine that it is discouraging to attempt a bibliography. The defect is partly remedied by the fact that hexiology is intimately related to other divisions of the subject: to anthropogeny, since all investigations into the evolution of man from a lower form proceed upon the assumption of the modifying and selecting function of environment; to anatomy and psychology, since climate, food, and natural enemies perfect or dwarf the bodies of men not less than their minds; to ethnology, since the races of men are almost universally believed to be the product of surroundings; to language and technology, since words as well as implements have reference to what is at hand and not to something outside of experience; to art and enjoyment, since the sense of beauty grows by what it feeds upon, preserves and reproduces that which has contributed to its indulgence; to society, since tribal organization and government are well known to be the sport of geography; to religion, since the gods, the temples, the vestments, and the routine of worship are very much the creatures of the land where they had their origin.

#### XI.—INSTRUMENTALITIES.

The purpose of this section has been so frequently explained that no repetition is needed. Museums, libraries, associations, congresses, jour-

nals, improved implements and methods of observations, popular works, and lectures, all are indispensable to the anthropologist. Hence, a list of the most important is appended. This becomes the more valuable at this time. Since the numberless publications on anthropology abroad cannot find a place in our list, the journals and separate works in which their titles are given will be found under "Instrumentalities." In this manner nearly every issue of importance will be placed within the reach of American students.

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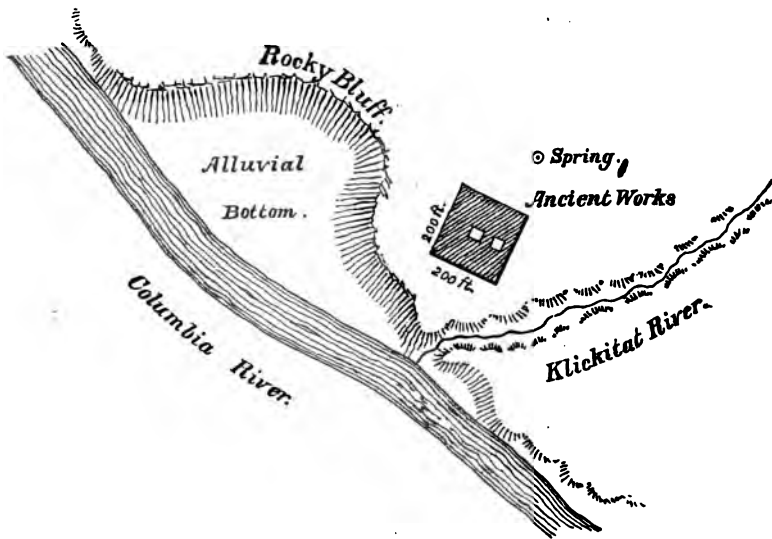


## MISCELLANEOUS PAPERS RELATING TO ANTHROPOLOGY.

### ABORIGINAL WORKS AT THE MOUTH OF THE KLIKITAT RIVER, WASHINGTON TERRITORY.

By T. M. WHITCOMB.

The works represented in the accompanying sketch consist of a stone wall 5 feet high, filled inside with earth, except the two squares within. These are 8 feet deep and 15 feet on each side, the whole work being about 200 feet on either side. There was formerly some kind of wooden structure on the stone wall, as the remains of cedar timbers occur at certain points on the top. The wooden work was evidently destroyed by fire, since all the cedar is charred.



None of the Indians in this country have any knowledge of the builders or of its use. There is a tradition among them that it was finished a long time ago. Large quantities of arrow-heads are found in and about the works. The place is eminently adapted for defense, being 100 feet above the river. The scarcity of aboriginal works of a permanent character on the Pacific coast makes this an object of peculiar interest to the archæologist.

## MOUNDS NEAR EDWARDSVILLE, WYANDOTTE COUNTY, KANSAS.

BY E. F. SERVISS, *of Wyandotte City, Kansas.*

On the farm of William Kouns, on the Kansas Pacific Railroad, near Edwarsville, Wyandotte County, Kansas, 14 miles west of this city, there are four mounds that have never been explored. They are situated on the third terrace of the valley of the Kansas River, about one-half mile from it, near a small creek. There is a very large spring about 200 yards northeast, and a smaller one about 300 yards northwest. On approaching the mounds from the east we find them extending in a straight line in a due westerly direction. They are about 6 feet in height, 25 feet in diameter, about 50 feet from each other at the base, and of uniform size. They have been somewhat injured by cultivation, the ground having been plowed twice. The soil is a black loam. Before the clearing of the land the mounds were covered with a heavy growth of timber, principally oak, and the stumps now remaining would indicate great age, averaging from 3 to 4 feet in diameter. A large number of axes, celts, arrow-heads, and other implements have been found in the immediate vicinity of the mounds.

About two years ago I discovered on the farm of J. L. Stockton, 1 mile northwest of this city, remains of an aboriginal workshop or village. It is located on a small stream, called Jersey Creek, and near a large spring. It covers an area of about 2 acres. The soil is sandy, and to the depth of 2 feet is a complete mixture of flakes of flint, ashes, bones (both animal and human), fragments of ornamented pottery, broken and unfinished stone implements of nearly every description. The fragments of pottery are the most numerous; there are three kinds as to color; viz, black, brown, and red, composed of a mixture of clay, sand, and pounded shells. The variety of the combinations of lines and dots is inexhaustible. I have never found two pieces alike.

Judging from the degrees of curvature of the fragments, the original vessels were mostly globular, and would hold from one-half pint to one quart. I found a very small vessel, containing powdered bone or lime; it was globular in shape, would hold about one gill, and was profusely ornamented. There are no deposits of flint and other stone valuable for arrow-making, &c., in this vicinity. The axes, celts, skin-dressers, and balls are all made of porphyry, and the arrow-heads of flint.

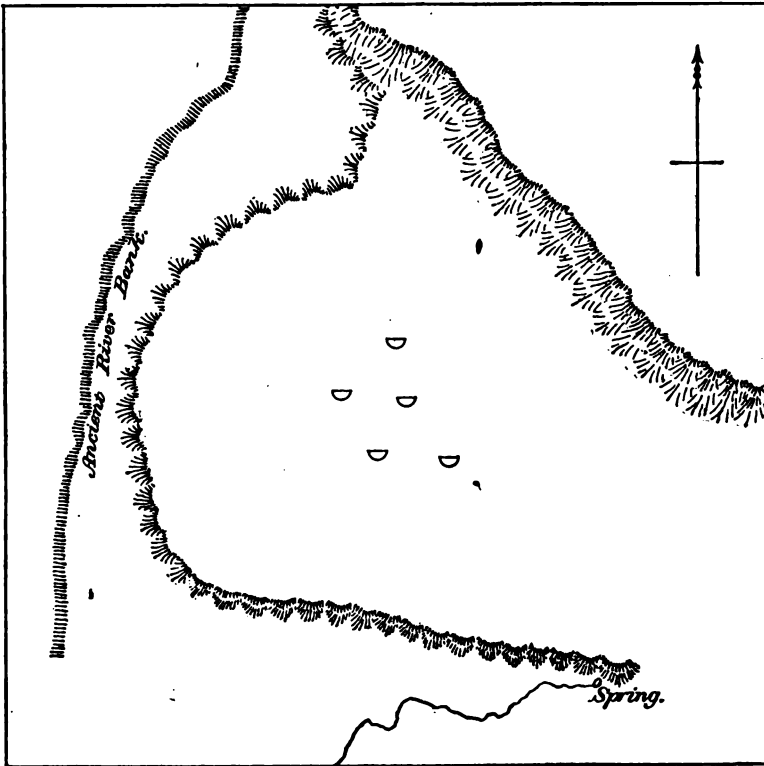
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## ANTIQUITIES OF MILLS COUNTY, IOWA.

BY SETH DEAN, *of Glenwood, Iowa.*

Mills County is located on the extreme western boundary of Iowa, and is the second county from the southern boundary. Immediately prior to its settlement by the whites it was the home of the Pottawatomie

Indians, numerous traces of whom may still be seen, but the two places to which this article refers seem to have an earlier date. The sketch marked No. 1 is a point in the southeast corner of the southwest quarter section 8, township 73 north, range 43 west of the fifth principal meridian, and on the lands now owned and cultivated by Mr. O. E. Allis. Topographically considered it is located on a spur of the bluffs.

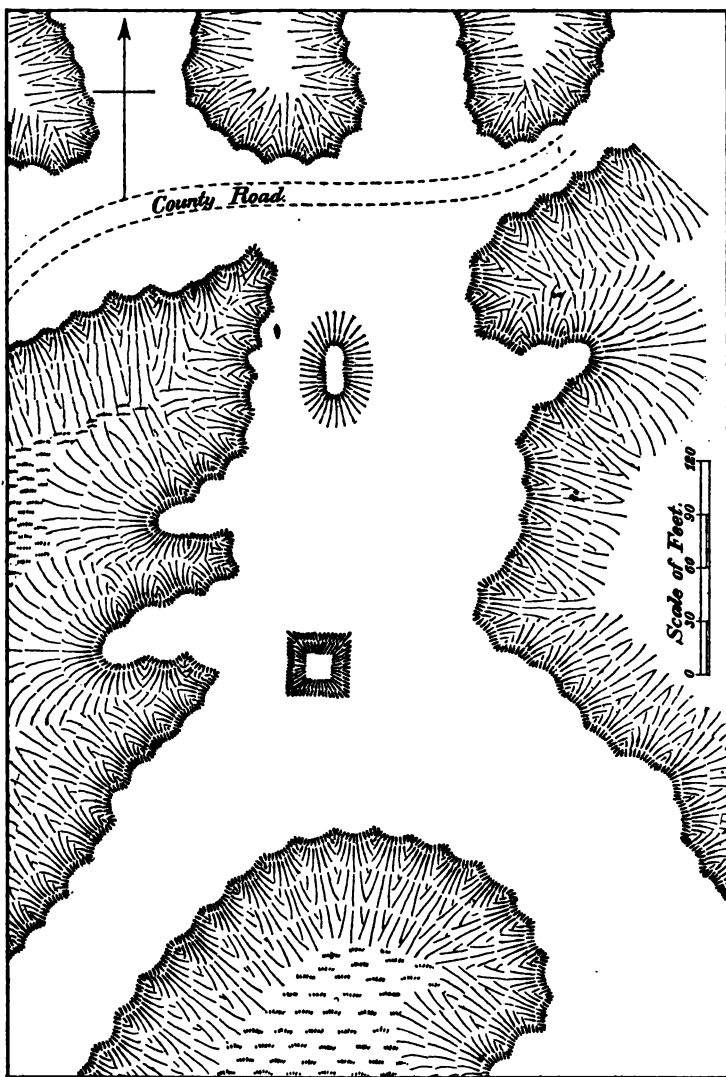


Sketch No 1.

which form the eastern boundary of the great Missouri flood plain, and is perhaps 50 feet above the level of the plain. The remains at present consist of a number of circular depressions on the southwestern slope, but near the summit of the aforesaid point of bluff. To the south about 400 feet there is at present a deep ravine, from which flows an excellent spring of water, while east and north the range of bluffs rise to a height of 250 feet above the plain. The depressions are from 20 to 30 feet in diameter, of circular form, and at present are from  $1\frac{1}{2}$  to 2 feet deep, but as the ground has been in cultivation for a number of years, it is probable that they have been filled up considerably.

The ground on the site and for some distance around these hollows is strewn with small chips of stone and fragments of pottery, together with occasional tools of various kinds, such as arrow-heads, knives, &c. Also a number of pieces of different-colored paints and occasional orna-

ments have been found. The inhabitants seem to have understood the manufacture of pottery to some extent, as numerous fragments show. The clay for this they obtained in the bank near at hand. This was probably mixed with the lime of powdered clam-shells, and then molded



Sketch No. 2.

into shape, and probably the larger vessels were supported by wicker-work made from small twigs, as there are numerous specimens which seem to show such an arrangement, although no perfect vessels have been found here, nor is it certain whether the vessels were baked in the fire or not.

The writer thinks the inhabitants lived mostly upon the products

from the water, as the shells of the fresh-water clam are numerous, and were obtained from the Missouri River, which at that time probably flowed along the foot of the bluff, at their very door.

The stone for their implements seems to have been obtained in part from some ledges near here, and perhaps some of it from a distance, as the finer and more perfect of their tools were made from a kind not found here, except in the form of pebbles or drift boulders, all the native stone being a carboniferous limestone, with the exception of a very coarse flint which is met with in some localities, and which was used for the larger tools, but which apparently was not suitable for smaller implements. Chalcedony seems to have been used by them to some extent, as were other kinds of stone of which the writer does not know the name. Some of these tools show superior skill, and have been apparently first chipped into shape and then ground to a perfectly smooth surface. This is the case with some hatchets which have been found, also of a globular stone which the writer has in his collection, and which was probably used as a sling-shot or for a similar purpose.

Sketch No. 2 shows the location of a peculiar mound, which is situated on the summit of one of the highest of the range of bluffs which borders the Missouri River flood plain. It is near the northwest corner of the northwest quarter of the southeast quarter section 10, township 72 north, range 43 west of the fifth principal meridian, and is about  $5\frac{1}{2}$  miles south and 2 miles east from No. 1.

This bluff is nearly 300 feet above the lowlands, and overlooks the country for many miles in every direction. The mound in question was formed of the soil adjacent, and is at the present time about 8 feet in height above the original surface. The base of the mound is elliptical in form, being about 70 feet north and south, and 40 feet east and west. The earth from which this mound was made was apparently taken from a place 125 feet south, where a large depression exists, about 35 feet square, and at present 5 feet deep. There is the stump of a burr-oak tree 16 inches in diameter standing near the northwest corner of the pit, on the edge of the slope of the bank; also another burr-oak stump 14 inches in diameter near the southeast corner, which is also on the bank, but at the edge of the excavation. This mound was partially opened some twenty-five years ago, but without yielding anything of consequence. My note-book shows the following entry: "Opened mound with S. B. Proudft, November 25, 1879, and dug a hole 6 feet long and 4 feet wide. At 7 feet from the surface came to a layer of ashes about one-half an inch thick, and below this a layer of stones. These stones were from 2 to 11 inches thick and would probably weigh from 20 to 30 pounds. They were evidently placed on what was the original surface of the ground, and the ashes and earth placed above them. The stones were probably brought from the Nebraska side of the Missouri River. About 4 miles directly west the characteristic fossils in the stones indicate this. There did not seem to have been any



action of fire on the stones, so far as we could discover, neither were there any bones or implements found in the mound, although we dug down 3 feet below the layer of stone. There were a few chips of flint found on the ground around the base of the mound, and a large stone implement which the writer thinks may have been used for a hoe, but belonged to a later tribe than the one which built the mound." (See Fig. 1.) Two cemeteries are also found in the county, but no examination has as yet been made.

## DESCRIPTION OF MOUNDS AT SNAKE DEN, NEAR SALEM, HENRY COUNTY, IOWA.

BY W. V. BANTA AND JOHN GARRETSON, *of Salem, Iowa.*

There are many unexplored mounds in Henry County, Iowa. The group examined and here described are 3 miles west of Salem, in section 22, on land owned by Mr. Joel Jones, at a place known as the Snake Den.

1. The first one in the group is 8 feet high, and 20 feet in diameter. It was opened by the authors, but nothing of value was discovered within. A burr-oak 26 inches in diameter was growing on the summit. The land slopes gradually westward to Little Cedar Creek.

2. Sixty feet from No. 1 occurs a burial mound nearly level with the surrounding surface and 20 feet across. It is covered with flat rocks. (A large quantity of bones of all sizes were encountered, but none of them were whole, and some appear to have been burned.)

3. No. 3 is 60 feet from No. 2. It is 3 feet high. It was not very thoroughly opened. In it was found one body, lying at length, between flag-stones, the head toward the north. The bones were badly decayed.

4. This mound is the usual distance from the last mentioned. Indeed, to avoid repetition, it is a remarkable fact that each of the mounds in this row is just 60 feet from the preceding. This mound was 3 feet high and 20 feet in diameter. It was but partially opened, and three skeletons were found, badly decayed, lying at length, the heads to the north.

5. The fifth mound in the series is 5 feet high and 20 feet in diameter. The top was covered with smooth, flat rocks, arranged in the shape of an elongated hexagon or coffin lid, with stones set edgewise around the border. Five feet beneath the top, that is, on a level with the natural surface, two bodies were lying at full length, the heads toward the north.

6. The sixth mound was not opened. It is 30 feet in diameter and 5 feet high.

7. The next in order, No. 7, is also 5 feet high and 20 feet in diameter. It was only partially explored, revealing a few human bones. On the top there are two trees growing, one of them 2 feet in diameter.

8. No. 8 is 5 feet high and 30 feet in diameter. It had been opened

previously to the visit of the authors. It is said to have contained a stone vault, in which were discovered human crania, &c. These were very badly decayed. A sandstone mortar and arrow-points were also found. The burial seems to have been in a sitting posture.

9. The first eight mounds are in a right line, but No. 9 is 60 feet east of No. 8. It was 5 feet high, and yielded nothing upon exploration.

## MOUNDS IN RALLS COUNTY, MISSOURI.

BY GEORGE L. HARDY AND FRED. B. SCHEETZ, of *Monroe, Mo.*

The only ancient remains in Ralls County, so far as known to the writers, are what are commonly called mounds. They are located on Salt River, a western tributary of the Mississippi, passing through townships 55 and 56, in ranges 5, 6, and 7 west of the fifth prime meridian.

The mounds are invariably found within less than a mile of a stream affording a permanent water supply. They are always in the bottoms or on the crests of bluffs and ridges, bordered either by the streams or the bottom lands, mostly by the latter.

It is impossible to state what changes have taken place in the course of the streams since the erection of the mounds, but doubtless in some places they have been very great. The growth of timber is universally the same on the mounds and in the surrounding forests.

Occasionally a single one is found, but they are almost invariably in groups, numbering from 3 to 10, and sometimes more. Commonly they follow the crest of the ridge, but when they occur in the bottoms or on a level bluff they are found in direct lines or in gentle curves, extending generally east and west. They exist in large numbers in almost every bottom and on nearly every bluff, on both sides of the river, throughout the entire county, as well as on its branches near the main stream.

The mounds are usually circular in ground plan, and rise above the present level from 2 to 12 feet. They are composed either wholly of earth, wholly of stone, or of the two combined. Where stone was used at all, the plan seems to have been first to pave the natural surface with flat stones in one or two thicknesses for a foundation. In one case the stones were thrown together indiscriminately. Peculiar constructions will be more fully noted in the descriptions given below of mounds examined by the present writers.

The stones were procured from the beds of the neighboring streams or from beneath the bluffs. Rarely can it be determined whence the earth was taken, there being only one example where there was any indication of the removal of the earth in the vicinity.

Human remains are almost invariably met with, only one exception being noted. The bones are generally very much decayed, though each bone is found almost entire, except those of the head. This seems to have always rested on a stone, and to have been covered by one or more, so that it is always found in a crushed condition. In stature the skeletons indicate a variation from 5 to 6 feet. No jaw-bone or even a fragment of one has been found from which the teeth were missing, and of the scores of teeth recovered there has been but one decayed, a wisdom tooth still in place. The teeth invariably indicate mature or advanced age. The human remains found in mounds constructed wholly of stone are generally much more decayed than those in mounds of mixed material. In rare instances stone implements, pipes, &c., are taken from the excavations, but these are more frequently picked up on the surface at no great distance from the remains.

So far as known, no accounts have been published concerning these mounds, nor have any systematic examinations been made.

As the stones used in their construction were of a kind useful to the early settlers in walling up their wells, laying foundations, building chimneys, &c., nearly all such material has been removed, so that it is rare to find a mound that has not been disturbed to some extent.

Since all the bottom lands are now in cultivation, those in such locations have been plowed down for many years. But where they are tolerably large and built principally of stone, as is generally the case, they are still well defined. Those that are situated on timber lands have the same growth of trees upon them as in the surrounding forests, if they are composed wholly of earth. In some cases white-oaks 2 feet in diameter or more are found on the very summit as well as on the slopes.

In the southeast quarter section 6, township 55, range 5, owned by Mr. J. Brashear, on the right bank of Salt River, is a row of mounds on the top of the bluff, which rises precipitously and then slopes back to the interior. There are twelve of them, the three southern ones being in a cultivated field, the others in the native woods. They vary in distance from 20 to 70 yards and in size from 20 to 50 feet in diameter, and in height from 2 to 5 or 6 feet. Except the south one they are of mixed material. That was wholly of stone, which was mainly removed by Mr. Brashear some forty years ago, when he commenced his improvements. He found in it a single human skeleton of large size. The fourth from the south was examined by us a few weeks ago by digging a ditch about 3 feet wide through its center. It is 58 feet in base diameter, and at the center  $5\frac{1}{2}$  feet above the general surface, having several white oaks growing upon it as large as any in the woods. The base was of flat limestone, thrown together without order; above this a layer of earth, another of stone, and so on to the top. No relics were found except a small fragment of pottery, a portion of a globular-shaped vessel, the inside of which was coated with a

greasy soot, which smutted one's hand like lamp smoke. This was found about 3 feet below the surface. Many such fragments have been, and some can still be, found on the field before spoken of. There was no indication of any decayed substance anywhere to be detected, nor of any action of fire, except on some of the limestones, which had evidently occurred before they were placed in the mound. The earth in this mound appears to have been taken from a portion of the field about 160 yards distant.

Southeast of the house of Mr. Robert M. Spalding, in the southeast quarter section 36, township 56, range 6, about 1 mile from the left bank of the river is a row of mounds, the western one of which was composed of stone of a peculiar color, only found in the vicinity on the right bank of the river at the distance of nearly 1 mile.

On the southeast quarter section 35, township 56, range 6, we opened a mound, one of several on the top of the ridge. On the south side of it the bed stone had been formed into a shallow trough. On removing the flat stones which covered this, and which showed no action of fire, we found a bed of charcoal several inches thick, both animal and vegetable, and the limestone which composed it was burned completely through. Some fragments of a human femur were found in a calcined state. There was no indication of fire elsewhere in the mound, but there were the partial remains of several skeletons, lying in two layers, with stone and earth between them. The implements marked with Mr. Spalding's initials were found in his vicinity, and are sent by him.

On the west half of the southwest quarter section 4, township 55, range 6 west, owned by Mr. Utterback, a row of mounds, four in number, is found, commencing on the brow of the bluff and extending back in nearly a westerly direction, in a slight curve for about 250 yards, at irregular distances. The eastern one is much the largest. The others are all in a field which has been cultivated for thirty years. One was examined and opened. Fragments of human bones were found on the surface, thrown up by the plow. On the north and south sides single skeletons were found, laid at length east and west, and between the two a confused mass of bones, as though a number of bodies had been thrown together indiscriminately. The diameter of this mound was about 30 feet, its height about  $2\frac{1}{2}$  feet above the general surface. It was composed of earth and stones.

On the northeast corner of section 8, township 55, range 6 west, owned now by W. Keithley, a mound was opened by one of the present writers (G. L. H.) in 1853. It was on the brow of the bluff, about 50 feet in base diameter, and at the center 5 to 6 feet high, and made wholly of stone; near the middle lay a single skeleton, indicating a person 6 feet 4 inches in height. It was extended at full length, with head to the west. A dry wall was laid up around the remains  $1\frac{1}{2}$  feet high, and this covered with large flat stone, on which the remainder were thrown indiscriminately.

Near the northwest corner of section 18, township 55, range 6 west, is an isolated conical hill, called the "Round Knob." Its crest is a narrow ridge about 150 yards long, on which are four mounds. The northern one was much the largest, and forty years ago portions of a dry wall still were standing, 4 to 5 feet in height. Human remains were found in all these mounds.

In section 24, northeast quarter, township 55, range 7, and on the opposite side (the left) of the river, is a similar but smaller hill, called "Wilson's Knob." Its crest is about 120 feet long, completely covered with stone to the depth of several feet, the pile being about 20 feet wide. On examination, made recently, it was found to have been originally a row of burial-places, nine in number, circular in form, each from 8 to 9 feet in diameter (inner measure), contiguous to each other. The remains of the walls still stand to the height of about 20 inches. Judging from appearances, it would seem that each had been of a conical or dome-like form. They were composed wholly of stone, and the remains found in them were almost wholly decomposed.

On the top of an opposite ridge to the west is another row, four in number, similar to those just described, except that the cists are square instead of circular, the sides being equal to the diameter of the former. In these also only small fragments of bones could be found. These last have been examined within a few days.

On the left bank of the river, about 1 mile below the "Round Knob" above referred to, are what are known as "The Painted Rocks," a number of rough representations of the human figure, about 20 inches in height. They are drawn on the face of the bluff, which overhangs so as to afford almost complete protection from the weather. This bluff rises 180 to 200 feet above the bed of the stream, and these drawings are 60 or 70 feet below the top. At the foot of the bluff are large masses of fallen rock and earth, filling up between the river and the bluff, and rising within 30 feet of the drawings. The central human figure is somewhat larger than the others, who are represented as approaching him in Indian file.

A single mound was found on the northwest corner of the southwest quarter section 12, township 55, range 7, on the point of a secondary ridge, near a small northern tributary of Salt River. It contained two skeletons, one with the head east, the other west. Beneath one of these a trench had been dug and filled up with stone, on which flat stone had been laid, and on which last the body had been placed.

## MOUNDS IN THE SOUTHERN PART OF PIKE COUNTY, MISSOURI.

BY JOSEPH C. WATKINS, of *Ashley, Mo.*

There are mounds in this section known as "Indian graves." The time of their construction antedates the settlement of this section by the whites. Some of the oldest citizens suppose that the mounds were the burial places of the Sacs and Foxes, but they say the mounds appeared as old when they first came here, sixty years ago, as they do now. I have found no one who ever saw or heard of the construction of one of these mounds. There are no other indications of a former occupation of this region by the aborigines that I have ever seen. The mounds visited by me are located in the southern part of Pike County, Missouri, as follows:

One mound on the land of L. M. Wells, southwest corner of the northwest quarter section 34, township 52, range 3 west, about  $1\frac{1}{2}$  miles southwest of Ashley; one on what is known as the "House Land," about the center of the southwest quarter section 28, township 52, range 3 west, about 2 miles west-southwest of Ashley; one on the land of James Farquar, northwest corner of the northeast quarter of the northwest quarter section 10, township 51, range 3 west; three on the land of E. G. Collins, near the southwest corner of section 16, and about 1 mile southeast of New Hartford; two on the land of Benjamin Young, northwest corner of the northwest quarter section 24, township 51, range 3 west; three on the land of John Motley, near the southeast corner of section 24, township 51, range 3 west, and near the junction of the creeks North Cuivre and Indian, and nearest the post-office of Louisville, Lincoln County, Missouri; two on the Coperhaver farm (now occupied by Nunc Estis), about  $2\frac{1}{2}$  miles south of Louisville, Lincoln County, Missouri.

All the mounds in question are situated on high points of land, forming bluffs to the creeks Cuivre and Indian. At the foot of the bluffs are good springs. Back from the bluffs the surface is undulating and tillable.

Three of the mounds are isolated, six in groups of threes, and four in groups of twos. All the mounds are circular. They are composed of soil and rock, some with the dirt and rock alternating, some of clay, with vaults of rock in the center. In the center of some there are rectangular vaults containing remains and soil. The material was probably obtained near by—the rock from the ravines and the soil from the banks of the same. Eight of the mounds have been partially explored—all of the Collins group, both of the Benjamin Young group, and Nos. 1 and 2 of the Motley group; also one of the isolated mounds on L. M. Wells' land.

In No. 1 of the Collins group the remains of two skeletons were found, with some fragments of pottery. In No. 2 of same, in a rectangular

vault, 4 by 5 feet, were found the remains of eight skeletons, with a few pieces of pottery. In No. 3 of same, a vault made of flat rocks, in the shape of a coffin, containing a few pieces of cranial bones, very much decayed. In No. 2 of the Young group nothing was found. In No. 1 of same, a large vault, the dimensions of which we did not have time to determine, contained human remains, much decayed, among which were found three flint arrow-heads, a small vessel molded of clay and burnt, and a pipe carved out of steatite, having upon its front a figure-head. In No. 1 of the Motley group bones were found, and among them a piece of pottery which shows some attempt at ornamentation, and a peculiar rock, oblate-ellipsoidal in form, with depressions (central) on its opposite sides. Around these depressions are 36 marks, arranged in groups of threes. All seem to have been diminished in altitude by continued exposure to the elements.

Trees were growing upon all the mounds, but some of them have been cleared. On the apex of No. 1 of the Motley group an oak tree had grown 22 inches in diameter, but was blown down, and now lies in the last stages of decay. Large oak and hickory trees have grown upon the other mounds.

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## ANCIENT ROCK INSCRIPTIONS IN JOHNSON COUNTY, ARKANSAS.

BY EDWARD GREEN, *of Clarksville, Ark.*

Five miles north of Clarksville, Johnson County, Arkansas, in section 7, township 10 north, range 23 west, is situated a cavern, or rock house, as it is commonly called, rather remarkable for its shape and the inscriptions on its walls. This cavern is in the southern side of a solid mass of sandstone that crops out on the crest of a hill, which rises some 200 feet above a small stream that flows by its southern base.

The cavern presents the appearance of having been worn out by the action of running water in some remote geological period, and in shape approximates a quarter section of a sphere. It is about 50 feet wide, 25 feet deep, extending into the rock, and about 10 feet high.

A partition, or rather two pillars of rock, descending from the dome or roof to the floor, divides the cavern into two chambers, of which the western, or left-hand one as you enter, is three or four times as large as the other. This partition divides the entrance into two semicircular apertures, which, together with the high, bold, and retreating mass of rock above, give it the appearance of an enormous skull buried to the orbits in the earth. This, together with a peculiar resonance produced whenever the floor is forcibly struck, must have caused this place to be held in reverence and awe by the superstitious aborigines. The cavern is somewhat difficult of access, and could have been easily defended in time of war.

On the walls of the larger chamber curious characters have been cut into the rock to a depth varying from one-fourth to one-half inch, by some blunt instrument in the hands of an unskillful sculptor.

Upon my last visit to this interesting spot, with the assistance of Mr. C. E. Robinson, of Clarksville, Ark., I succeeded in tracing these characters on paper, which I afterward reduced to one-sixth the size of the originals, by means of the *camera lucida*, thus preserving their true outlines and proportions; a traced copy of which accompanies this article.

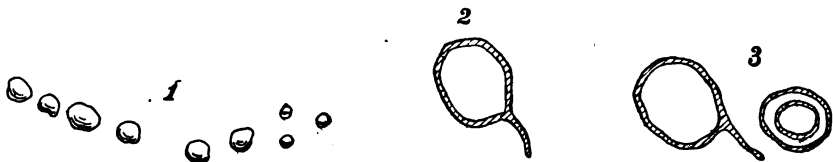
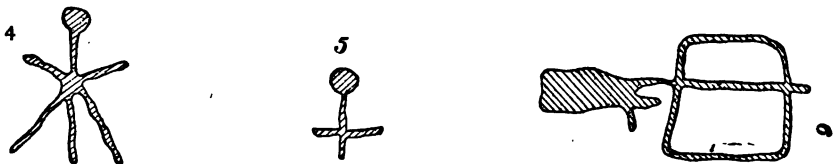


Fig. 1 represents hemispherical depressions or holes in the floor of the cavern, near the left entrance and a few inches from the wall. They are arranged in an arc-shaped row, with concave side to the wall.

Fig. 2 and the first character in Fig. 3, which occur above Fig. 1, on the wall, are incised circles, each 7 inches in diameter, and have each a single ray pointing downward and to the right. The other character of Fig. 3 consists of two concentric circles, the outer one measuring  $5\frac{1}{2}$  inches in diameter, and the inner one 3 inches.



Figs. 4, 5, and 6 occur to the right and at about the same height as Fig. 3. Fig. 4 measures from top to bottom  $11\frac{1}{2}$  inches; Fig. 5, 7 inches, and Fig. 6, 23 inches.



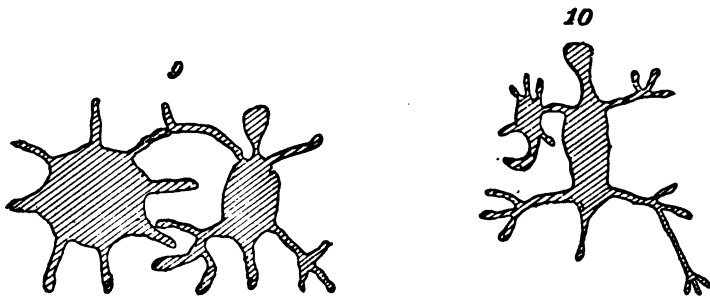
Fig. 7 is a double character. The one on the left may represent the antler of a stag, the other a bow. The whole figure from left to right measures  $23\frac{1}{2}$  inches.

Fig. 8 is a rayed character with a circular body chiseled out to the depth of the rays, viz, one-fourth inch. The body of this figure is  $4\frac{1}{2}$



inches in diameter, and the length of its rays about  $2\frac{1}{2}$  inches. One of the rays connects with a similar but smaller figure.

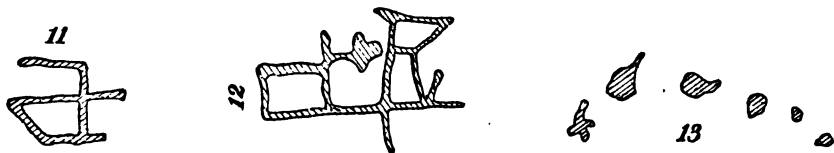
Fig 9 is also a double figure; the first character is like Fig. 8, but larger and has one ray less. The body of this figure measures  $7\frac{1}{2}$  inches



in diameter, and the length of the rays from 2 to 3 inches. The second character represents some reptile, as the tortoise, and measures from head to tip of tail 13 inches. The bodies of these figures, like Fig. 8, are cut to the depth of one-fourth to one-half inch.

Fig. 10 is another double object and might have been intended by the unskillful sculptor to represent a lizard with its prey or young. The smaller figure is reversed. The larger figure, from head to tip of tail, measures 15 inches; the smaller one, 7 inches.

To the right of the characters represented in Fig. 10 are two charac-



ters, Figs. 11 and 12, which are somewhat confused, and were difficult to trace, as they are surrounded by a multitude of indistinct lines and cuts. The sculptor had perhaps spoiled his figure and tried to obliterate it.

Fig. 13 are small irregular depressions in the wall of the cavern, to the right of the character represented by Fig. 14.

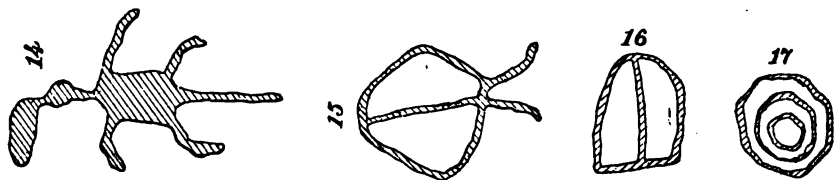


Fig. 14 is another reptile, with a peculiar swell on the neck and an elongated head. The length of this figure, from head to tip of tail, is  $19\frac{1}{2}$  inches.

Figs. 15 and 16 occur still further to the right, and appear to be of a more recent period, and cut with a better instrument or by a more skillful sculptor.

In the rock floor of the smaller chamber is a round hole 19 inches in depth and  $7\frac{1}{2}$  inches in diameter at the top, and about 4 inches at the bottom; probably used for a mortar by the ancient cave-dwellers.

On the roof or dome there are several figures, as represented by Fig. 17, that have been painted on the surface of the rock and are now faded to a pale gray.

I found no spiral figures of any kind here, which occur so frequently among inscriptions of this character in other localities.

No stone implements of any kind, except a few broken pieces of arrow-heads, have been found in the vicinity of this cavern.

The sculptured characters here described are undoubtedly of ancient origin, and the only ones that have been discovered in Johnson County. However, I have been informed that similar inscriptions occur in Newton and Carroll Counties, of this State.

## MOUNDS AND OTHER REMAINS IN INDEPENDENCE COUNTY, ARKANSAS.

BY A. JONES, M. D., of *Caddo Gap, Ark.*

In the fork of White and Beach Rivers, Independence County, Arkansas, is a collection of mounds 2 or 3 miles each way in extent. They are 4 or 5 feet high, and laid out in rows in a semicircular form, about 6 miles above Jackson.

There is another group south of Suspension Rock, half a mile south, laid out in the same way.

On section 17, township 5 south, range 21 west, are two mounds 7 or 8 feet high, sunken at the top. Near by are depressions whence the earth for the mounds was taken. These have never been explored. They are on a piece of upland that has been cultivated and each had large trees growing on the summit. They stand about 2 miles from the Caddo River. There are two shell-beds near by, constructed of the common mussel, in which the coarse clay and shell pottery is found.

Four miles north of Amity, section 17, township 5 south, range 23 west, are several shell-heaps on a high and second bottom of the Caddo, entirely above overflow.

Another mound is in the Caddo Cove, 2 miles west of Black Springs, on the old Major Farr place, now owned by Dr. Gray. It is 5 feet high and has been explored. A depression 80 yards distant is the only spot in the vicinity whence the material of the tumulus could have been derived.

There are several shell-heaps on a high table-land bordering on the

Washita, in this county, 4 miles southwest of Cedar Glades, on the land of Robert Hansley. Fragments of pottery occur about the heaps. The beds are 40 feet above high water, indicating that the shells must have been carried to the spot.

On the south fork of Washita, section 24, township 2 south, range 26 west, near Mount Ida and at the upper ford of the creek, human remains, partly washed out, were discovered. The bodies were buried in a recumbent posture, the head to the west. The bones were too friable for preservation, the teeth alone remain firm. Forty years ago the ground was covered with a dense growth of cane. The bottom is a high one and above overflow. Many human remains have been plowed up in the vicinity. The cemetery must be about 200 to 300 yards long, and 75 yards wide. Near by, running east and west, are several small mounds, in the largest of which a former owner, Mr. Powell, was buried.

Three miles east of this point, in a bottom-land owned by Reuben McKenney, were plowed up the remains of a very large man. Pottery has also been found in the same vicinity.

On section 9, township 4 south, range 24 west, is an outcrop of novaculite or flint of a very tough quality and of various colors. From this material large quantities of arrow-heads, &c., have been formed. The ancient artisans went down on the south side of the outcrop, which is a ledge 700 or 800 feet above the adjacent valley, and carried away immense quantities. The material is the same as that of arrow-heads from Tennessee, Mississippi, and westward.

There is on Capt. R. S. Burk's farm, section 17, township 5 south, range 23 west, evidence of an extensive workshop in arrow-heads and cutting implements. The arrow material was taken from the quarry above described, although ten miles away. The cutting instruments were of the hatchet kind and made from a species of iron ore. There is another *atelier* near my home, section 7, township 4 south, range 24 west, Montgomery County, Arkansas.

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## MOUNDS NEAR THE NATIONAL HOME, MILWAUKEE COUNTY, WISCONSIN.

BY GEORGE W. BARBER, of the National Home, Wisconsin.

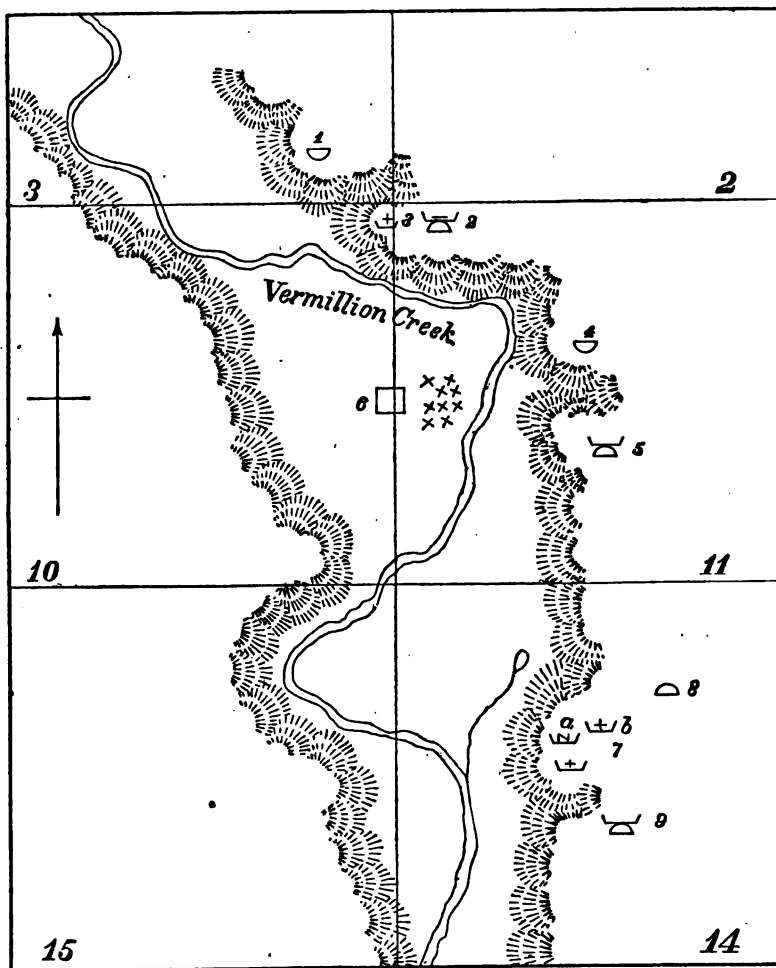
The mounds described in this paper are on land owned by Joseph Carey, nearly opposite the Dewy place (adjoining John R. Goodrich's farm), now occupied by E. P. Bacon. They are about one mile west of Milwaukee City limits, on the south side of National Home avenue, and on the west side of the Trowbridge road. The two that have been removed were upon land owned by William Trowbridge, lying south of and adjoining Carey's land. Two are in Wauwatosa township, two in Greenfield, and all are in Milwaukee County, Wisconsin. They are situated upon a swell of land from 20 to 100 rods distant

from what was once a shallow pond or lake. The land occupied by the lake has been partially drained within a few years, and is now a meadow. The surface around the mounds is covered with soil from 12 to 18 inches deep, and might have been used for cultivation. William S. Trowbridge and other old settlers have said that there are, or were a few years ago, hillocks or marks of Indian cornfields in this vicinity, and that they have seen Indian corn growing, planted by the Indians. The land to the west has been partially drained. There is no apparent arrangement of the materials. The center of the mound is not different from other parts. The material was probably obtained around the mound, as the soil is deeper under it than at its sides. All have been explored. I have taken bones from two of them, and have been told that pottery and bones were found in the other two. I have one good skull from No. 2, and leg bones, vertebræ, ribs, &c., from No. 1. No account of these mounds has ever been published, to my knowledge. Nos. 3 and 4 have been entirely obliterated for purposes of cultivation. No. 2 has been dug into. No. 1 is fast being undermined to obtain gravel for the streets of Milwaukee. For two years past I have watched with sad interest the destruction of this grand old monument of a decayed race, and secured the bones as they were exposed. It now presents a perpendicular section, running nearly through the center, of which a photograph might easily be taken. A maple and a red-oak tree grew upon the mound, each 18 inches in diameter. There are two red-oak stumps within two or three rods of No. 1, 3 feet across the shorter, and  $3\frac{1}{2}$  feet across the longer diameter. Judging from the soil around them, these trees must have grown since the mound was built. I have counted the annual rings of growth of one, and found them to number 155. I assisted in taking out of No. 1 the fragments of three skulls, and other bones of three skeletons. The skulls, vertebræ, and hip-bones of each skeleton were on about the same level, and in a space not more than 15 inches square. In one case the crown of the skull was downward, and the top on a level with the hip-bones. This position at first puzzled me, but I suppose that the body was buried in a sitting posture, and the superincumbent weight of the earth, as it settled and the flesh decayed, turned the top of the head downward by the side of the body, and it continued to descend until it reached the level of the hips. The faces, judging from the position of the legs, were toward the west. The bodies were not inclosed. One skull was quite well preserved, but the other bones were considerably decayed.

## EXPLORATIONS IN MOUNDS IN WHITESIDES AND LA SALLE COUNTIES, ILLINOIS.

By J. D. MOODY, *Mendota, Ill.*

The explorations noted in Plan I, were made at different times in company with Dr. Everett, of Troy Grove, and Dr. Edwards, of Mendota, Ill. Those noted in Plan III, were made in company with Prof.



Plan I.

Samuel Maxwell, of Lyndon, Ill. The "find" noted in Plan II, was made by some workman while digging for gravel.

The location of Plan I is about 4 miles in a southeasterly direction from the village of Troy Grove, La Salle County, Illinois. It is about 10 miles north of the village of Utica, on the Illinois River, near which was situated the great town of the Illini Indians, famous in the early history of Illinois.

All of the mounds discovered were situated on the bluffs on the eastern side of Vermillion Creek, a small stream flowing into the Illinois River.

No. 1 was a circular depression about 12 feet in diameter and 1 foot deep at the center. On trenching it we found evidence of a long-continued fire-place in the baked clay, burned stones, and fragments of charcoal, evidently the site of an Indian's fireside.

No. 2 was a mound 15 feet in diameter and 4 feet high, occupying a commanding position on a high bluff projecting out into the valley. The view from this point is a fine one, commanding the valley for miles in either direction. On opening the mound we made the following discoveries: In the center and just under the sod we found a great quantity of burnt bones, human and animal,—the latter those of dogs or wolves. From a careful examination of the fragments of skulls, we determined the remains of nine individuals. There was no evidence of fire in the soil. They had been placed there in comparatively recent times after having been elsewhere cremated. Along with these bones were found a few perfect arrow-points, numerous fragments, and a rude stone pipe fashioned somewhat like a spool.

On digging deeper, just below the original surface of the ground, was found a skeleton lying upon its back, with the feet toward the west. It was of an individual of average height and advanced in years, as indicated by the absorption of the alveoli and the angle of the inferior maxillary. The arms were extended along the body. The frontal development of the skull was of a low order, more so than is found in the Indian, and yet not so much so as is usually ascribed to the mound-builder. This was the only burial in a horizontal position discovered in this locality. A very careful examination of the soil about the head and upper parts of the body failed to bring to light any relics whatever. The burial was in a compact dry clay, and the bones in a crumbling condition.

No. 3 was a burial place on the point of the same bluff just spoken of. Nothing but bones were found in it, the remains of several individuals. One skull was taken out in good condition, lacking the inferior maxillary. The bones still preserved quite a portion of the animal matter, and indicated a comparatively late burial, presumably Indian.

No. 4 was a circular depression but a few feet in diameter, evidently, from the burnt stones, being a fire-place.

No. 5 was a mound about 10 feet in diameter and 2½ feet high. It had been opened a short time before our visit and a few bones taken

out. From the description we received we could form no idea as to the character of the interment. No implements of any kind were found.

No. 6, on a broad flat in the bend of the creek, is the remains of an Indian encampment; numerous fire-places just beneath the surface of the ground, broken flints, &c., being found.

No. 7 is a group of three mounds. Having been plowed over for years, they were nearly obliterated. The remains in mounds *b* and *c* were alike, each containing the bones of several individuals thrown in promiscuously. They were not burned, yet each mound contained great quantities of ashes and bits of charcoal. The bones crumbled on the slightest touch, and presented the appearance of having been leached. In mound *a* one skeleton in tolerable preservation was found. It had been buried in a sitting posture. Near the head was found a large mussel-shell filled with what appeared to be paint. A little to one side and at bottom of excavation was an ash-pile with about one peck of charcoal in the center of it. Neither ornaments nor implements were found. This group was evidently Indian in origin.

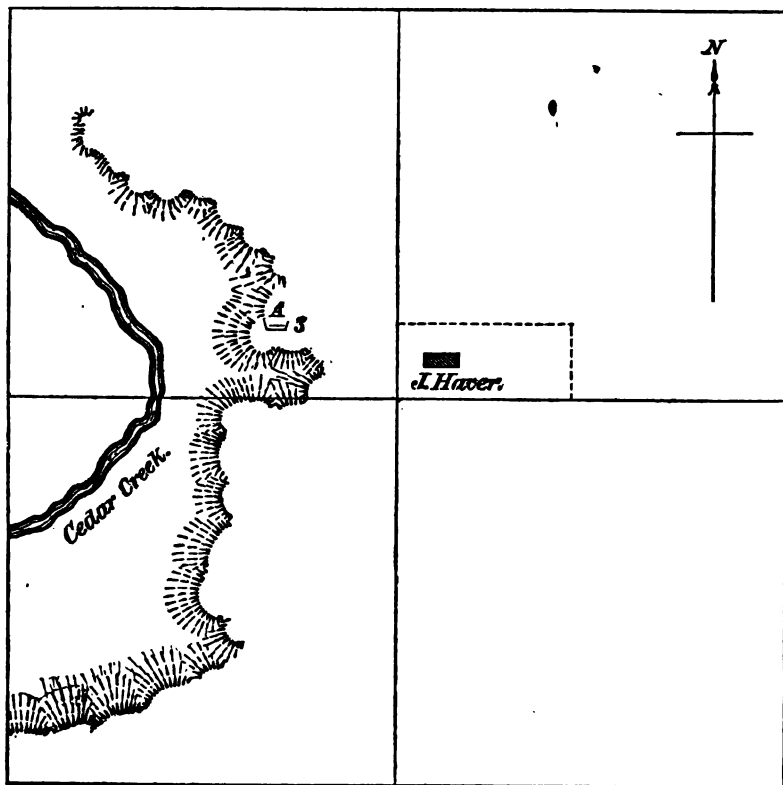
No. 8 is a mound 35 feet in diameter and 5 feet high. Though regular in outline and occupying a commanding position, yet from our examination of its structure we considered its artificial origin as doubtful.

No. 9 is a mound 12 feet in diameter. In it was found one skeleton very much decayed, and near the head a very rude earthen bowl, holding about one pint.

No other mounds are found in the vicinity. Scattered over the bluffs and fields are found quantities of broken pottery, arrow-points, flint chippings, stone axes, &c. A copper spear-point was also found in the vicinity. From my examination of them, I assign to them an origin and date, with possibly the exception of the horizontal burial in No. 2, as of the Illini Indians, and of about the beginning of the seventeenth century.

Plan II is located 4 miles southwest of the city of La Salle, on Cedar Creek, a small stream flowing into the Illinois River from the south. There were three graves two and a half feet deep, on a gravel point projecting out from the ridge. No mounds had been erected over them. They were close together. They were discovered by some laborers while digging for gravel. One of them, possessing a little curiosity, gathered up the bones and relics. One body was deposited in each grave, and in a recumbent position. The relics found consisted of several simple, rude pipes cut from sandstone, a few shell beads, arrow-points, and the fragments of a curious vase, holding, when reconstructed, about four ounces, and representing a man sitting on his knees, with hands folded across the abdomen. The opening was at the back of the head. It was composed of clay and powdered shells baked. The face presents strongly-marked Aztec features, or possibly an exceptional Indian countenance. The bones were very much decayed, with the ex-

ception of one side of one inferior maxillary. This was well preserved, and stained a deep green color. Not understanding the import of this, the laborers missed finding a copper implement of some kind. No other remains were found in the vicinity.



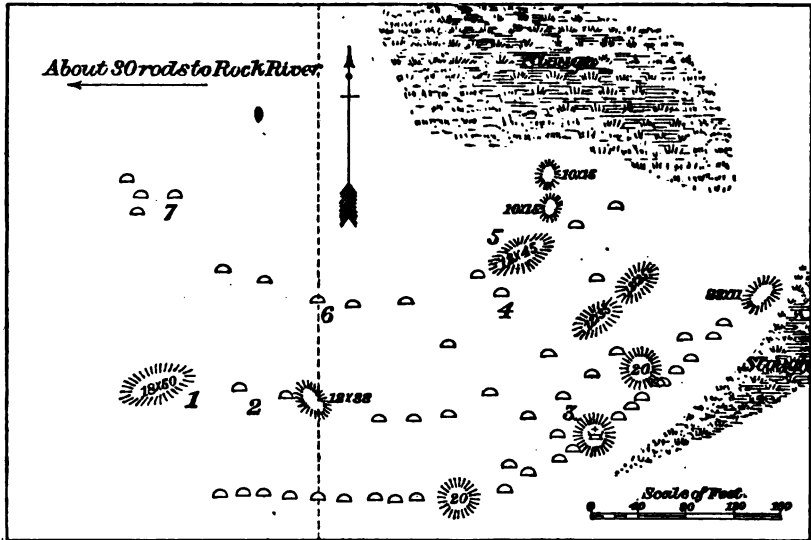
Plan II.

Plan III is a singular group of mounds 3 miles from Spring Hill post-office, Whiteside County, Illinois. The bluffs along Rock River are covered with mounds. This group, however, is on the alluvial bottom, about 30 rods from the river. Though there may be others on the lowlands, yet these are the only ones I found so situated. This group is in a semi-circular form, in quite regular lines, as will be seen by a reference to the plan. They are on a plat of ground a little higher than the surrounding level. They are surrounded on three sides by a slough, in earlier times probably communicating with the river, and this may have had some influence in shaping the crescent form of the arrangement. However, being on the ground, the impression cannot be resisted that there was some special design in the grouping.

While most of the mounds were round and of varying size, some of them were long and narrow. The figures inside the circles indicate the dimensions of the larger ones in paces ( $2\frac{1}{2}$  feet to the pace). Their rel-



ative sizes are preserved in the diagram. The ground is covered with timber. A stump standing on one of the mounds indicated an age of over two hundred years. The soil was a very hard, sandy clay. The



Plan III.

space A of the diagram was inclosed and used as a hog-lot. None of the mounds were over three feet high. Nos. 1, 5, 4, and 7 were opened, but nothing whatever was found. In No. 2 we found no bones, but two rude vessels, holding about one quart each, made of clay and coarse sand molded on the inside of a grass basket and then burned, as evidenced by the impressions of the grass on the outside. No. 3 contained the remains of several individuals, lying side by side, but too badly decayed to be preserved. No. 6 had been bored through years before for a well; quantities of broken bones were brought to the surface. Our time did not allow of any further explorations. The regularity in the arrangement of the mounds presented a weird appearance in the forest. Some of the mounds on the bluffs opened at same time yielded the same results. On one a white-oak tree, three feet in diameter, was growing. Rude vessels and stone axes have been found in the neighboring mounds.

ANTIQUITIES OF FOX RIVER VALLEY, LA SALLE COUNTY,  
ILLINOIS.BY W. HECTOR GALE, of *Wedron, Ill.*

Having recently had the pleasure of examining a portion of the Fox River Valley, about 8 miles from Ottawa, the capital of La Salle County, Illinois, the author gives below the results of his investigations. The valley abounds in picturesque scenery of rocky bluffs and wide, fertile fields. The surface rocks are the Saint Peter's sandstone and Trenton limestone of the Lower Silurian. The drift in many places is 40 feet in thickness, consisting of a bluish clay, very hard, which, when undermined, breaks into blocks with the regularity of stratified rocks.

The Fox River passes along the eastern side of the valley in this locality, and is, in ordinary times, very shallow and rapid. The stream has, in the remote past, covered the entire valley, about one-half a mile in width. The ground is eminently historical as being the region which was explored by those intrepid *voyageurs*, La Salle, Tonti, Marquette, and Joliet, also the scene of the almost romantic extermination of the Illini Indians by the Iroquois. Within a radius of a few miles, and especially within this immediate locality, were enacted some of the most sanguinary scenes of the Black Hawk war.

But relics of a still older people are unmistakably visible here. It may be well to add that the course of the river here is from north to south. Perpendicular bluffs, of Saint Peter's sandstone, rise along the eastern shore, which are washed by the waters of the Fox, even at low water, while along the western side of the valley are sloping bluffs from 20 to 60 feet above the river. My experience during the late war teaches me that, were an enemy expected from the south, this locality, on account of its natural advantages, would be fortified and made a very strong place. It would seem that this fact was not lost sight of by the prehistoric inhabitants. On the west side of the valley, on a point of the bluff highest above the valley, I find an earthwork commanding the surrounding country, and facing toward the east and south. The bluffs are divided from those south by the Indian Creek, which enters the Fox about one-quarter of a mile distant, coming from the west, and has cut out a valley from that direction. The general shape of the fortification may be seen by an examination of Fig. 1. The large mound at the corner is highest, rising some 5 feet above the natural surface of the ground. Some time since, an excavation was made in the center of the mound, and a few bones found, but they had perished to such a degree that it would be impossible to describe any of its characteristics in an intelligible manner. On either side of the mound referred to is a smaller one, about 2 feet in advance of the main line, giving a passageway, gate, or entrance on either side, yet not leaving space entirely open and unprotected. In the rear of the fort, Fig. 1, is a thick second growth of oak

and hickory. Immediately in front there are very few trees, but whether they have been removed by the builders of the earthwork, by a more modern race, or have never existed, I am unable to state. The valley,

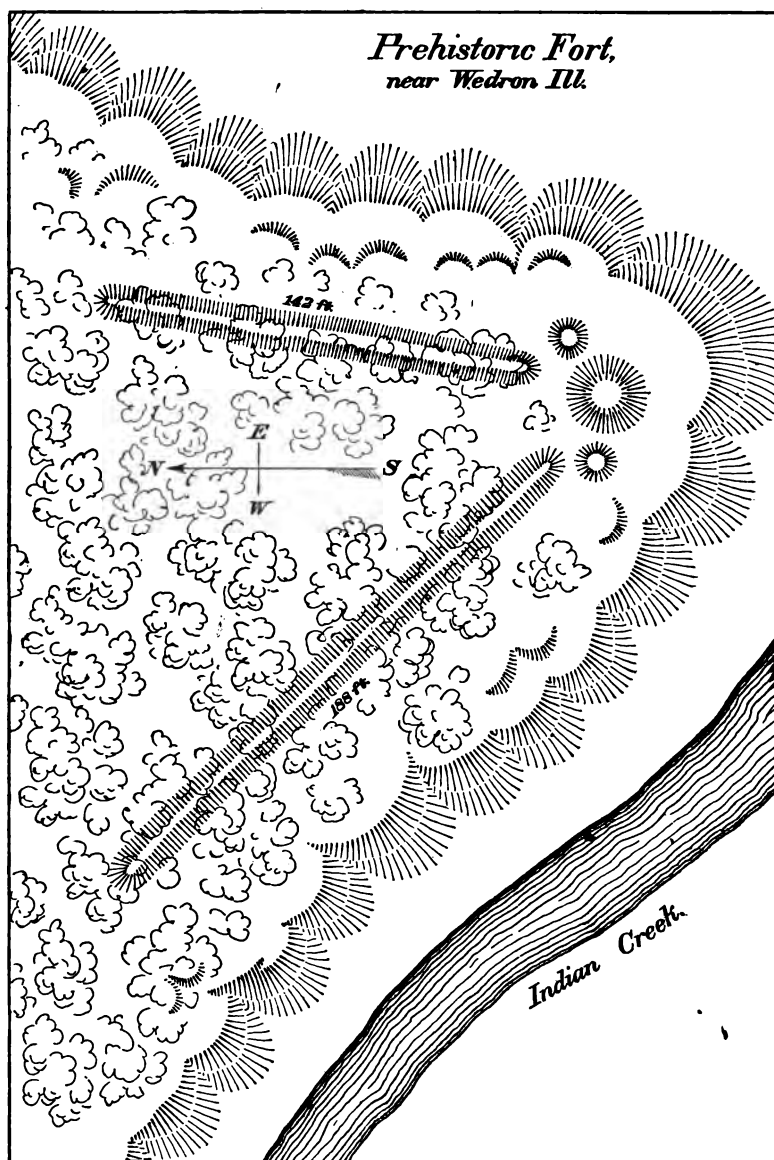


FIG. 1.

before cultivation, was a succession of mounds, crowded closely together, and the remains of many are still plainly visible. Some of these have been excavated, and in most cases found to contain skeletons, which, upon being exposed to the air, rapidly crumble away. In some cases stone

axes made of syenitic rock were found, and in one instance two earthen vessels or jars of rude workmanship. Across the river, in an easterly direction from the fortification just described, is another fort, facing in the same direction. This was surveyed by Col. D. F. Hitt, in 1877, and from this I take the drawing (see Fig. 2). The sand-rock is from 35 to 40 feet perpendicular above the river, and on the eastern side of the bluff is a ravine 65 feet deep, nearly vertical. The earthwork extends from the bluffs on the river side to the bluffs on the western side of the ravine.

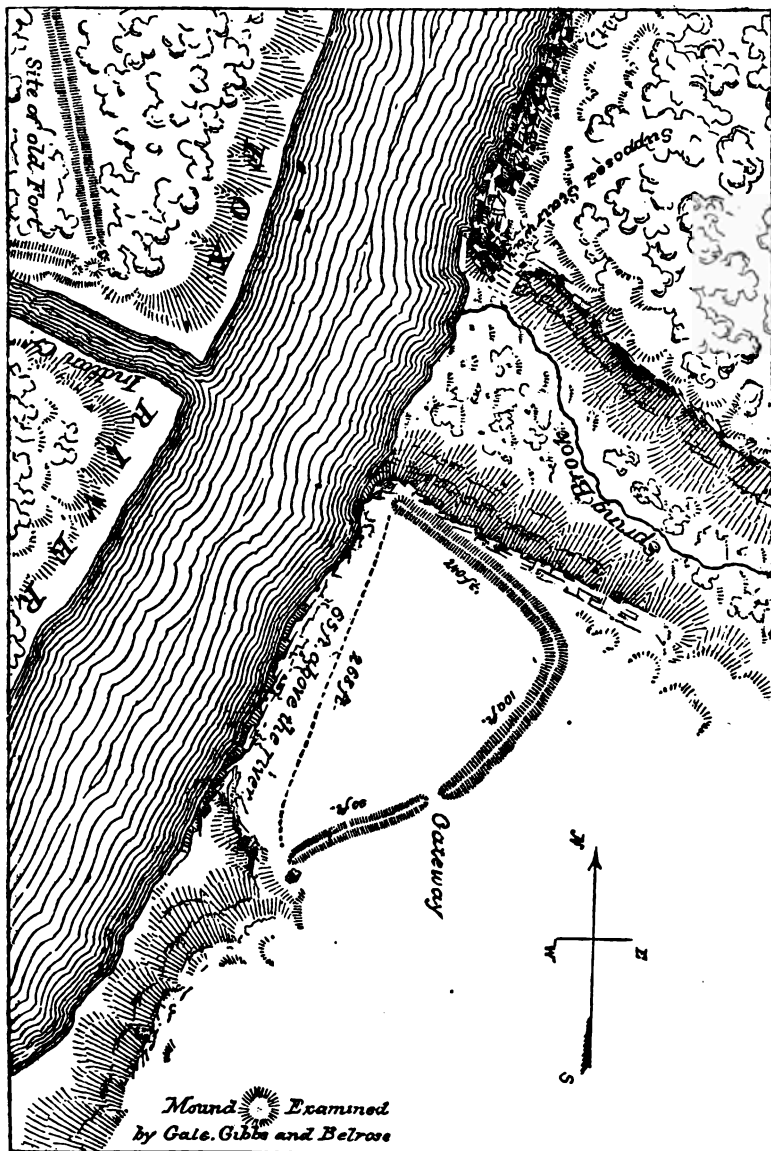


FIG. 2.

In my examination I discovered a mound about 80 rods south of the fort which bore no evidence of ever having been disturbed, and, in company with Mr. J. I. Gibbs, of Vermont, and Thomas Belrose, of Wedron, Ill., gentlemen interested in archæology, made an examination of its contents. About 2 feet from the surface we discovered charcoal in quite large quantities, and the skull, thigh bones, a fragment of the collar bone, and one joint of the vertebra of what had once been a member of the human family. Underneath was a number of granitic bowlders of quite large size, placed in a circular form, inside of which was found charcoal. Were I to give an opinion, I should say that the fact of finding but a small portion of the skeleton and charcoal in so large quantity is conclusive evidence to me of cremation. The skull was very narrow, with a rapidly sloping forehead, extremely heavy under jaw, and large teeth. The skull retained its shape but a few moments, when it crumbled in pieces. It was, when discovered, lying with the face nearly downward, and the head to the east.

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### MOUNDS IN HENRY AND STARK COUNTIES, ILLINOIS.

BY T. M. SHALLENBERGER, *of Cambridge, Ill.*

The locations of the mounds referred to in the title of this paper are indicated on the two accompanying plats. The first gives an outline of Henry and Stark Counties. The point marked A is  $1\frac{1}{2}$  miles south-west of Cambridge, and is more fully illustrated in plat No. 2.

At B is a group of fourteen mounds, 1 mile east of Cambridge, still unexplored.

In Peoria County, at the location marked C, is a large conical mound on the river bottom, which was excavated by the writer, but nothing of value was found, inasmuch as it had been previously opened. No doubt a body had been interred in this mound, since the slab which had lain over it was still there, and the ground at the original surface was burned hard. Two other flat stones close by had been probably taken from the mound, there being no other stones in the mound which could have been used to support the slab before mentioned. There are no other mounds in the vicinity.

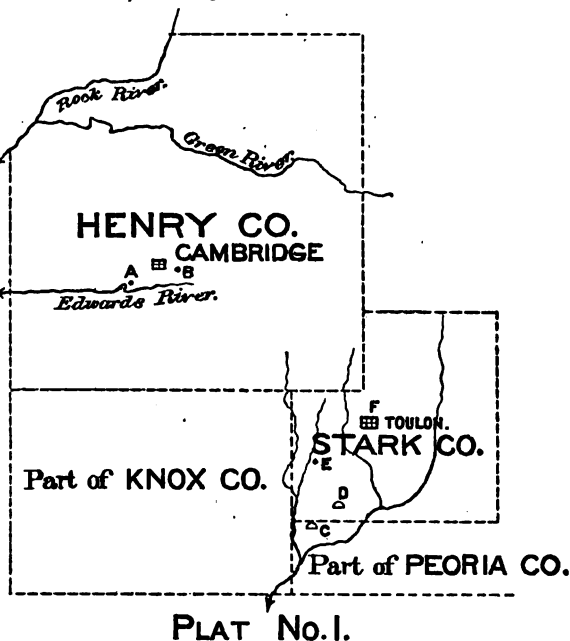
At D is a mound still unexplored. It is situated in West Jersey Township, and is yet 4 feet high, although it has been cultivated for several years.

The point marked E is a salt marsh, and would in all probability yield relics of prehistoric salt works and mastodon bones. Fragments of pottery have been discovered here already, but the exploration of this spot would be attended with considerable expense.

In the corporation of Toulon, marked F, from a very low mound were taken two axes and some white flakes like enamel. Judging from the deposits, as well as from the mold, a body had been interred here.

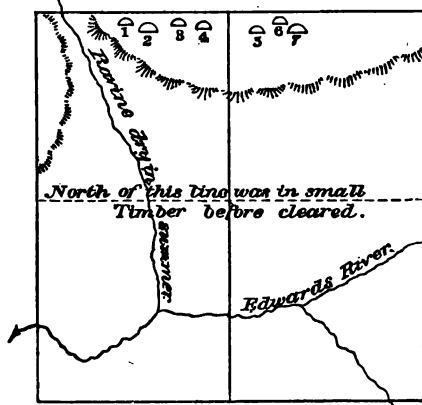
In the northeast of Henry County, at a point marked G, are immense sand-hills and swamps. The mound-builders evidently made this a rendezvous for game and fish, the sand-banks abounding in all kinds of relics. This is the Winnebago swamp, and scattered through it are many evidences of ancient inhabitants.

As mentioned above, Plat No. 2 is in enlargement of point A in Plat 1. The mounds will be described in the order of the numbers in the figure.



1. The mound was opened and a polished agate was found, about the

PLAT No. 2. 1 MILE SQUARE.



size and shape of a hen's egg, but more pointed. Both this mound and No. 2 are still covered with timber.

3. Nothing but ashes was found in the bottom of this mound.

4. At the bottom, the stump of a crab-apple tree was discovered, which had been felled by a blunted tool. Another tree had grown on the surface of the mound, and the roots completely surrounded the ancient stump beneath. Another mound formerly located at this point has since

been obliterated.

- 5, 6, 7. Permission to open these could not be obtained.

All the mounds mentioned in this paper are about the same size, 30 feet across, and  $2\frac{1}{2}$  feet high, and are built of material found on the spot. The last named are on the land of Peter H. Nilson.

## ANTIQUITIES OF KNOX COUNTY, ILLINOIS.

BY M. A. McCLELLAND, of Knoxville, Ill.

The drainage of the eastern and southern part of Knox County, Illinois, is accomplished by numerous small streams navigable in the spring for canoes. Their general course is toward the southeast to empty into Spoon River, a tributary of the Illinois. In the northwestern part of the county numerous other small streams have their rise, and, running to the west, finally empty into the Mississippi. The portage between the headwaters of these streams is only a few miles in extent.

The trails anciently followed by the aborigines have now entirely disappeared, but along their former course, and upon the bluffs of the streams, are still found implements of war, amusement, and the chase. The discoidal stone, stone hatchet, and arrow-points sent to the National Museum were all found upon the north bluffs of Court Creek, principally upon sections 13, 14, 15, 16, township 11 north, range 2 east, Knox County, Illinois. The stone axes, and arrow-points came also from these sections, except the largest, which came from Haw Creek, section 3, township 10 north, range 2 east.

To all the interrogatories contained in circular No. 316 I return a negative answer, except as to mounds and cemeteries.

*Mounds and excavations.*—No. 1. One and a half miles west of Knoxville, on section 30, township 11 north, range 2 east, Knox County, Illinois, on the east side of a ravine running into Haw Creek, on a level piece of timber land belonging to Harvey Montgomery, esq., is a single mound 51 feet in diameter, and at the center about 3 feet above the general surface. The trees upon this land are of two ages, viz, first, large oaks, elm, &c., 2 feet 8 inches in diameter, and a smaller growth, of black-jack, and white oak, ash, hickory, &c., 6 to 8 inches in diameter. The mound is surrounded by six or seven of these larger trees, one on the southwest edge of the mound, the others, west, north, northeast, east, and south. east, at variable distances, from 20 to 32 paces. Upon the mound there are numerous trees, of from 3 to 6 inches, growing. There are very large areas of ground in this same timber, in which the larger trees are very sparsely scattered. The mound is circular in form, and 60 feet S. S. W. is a circular pond or excavation, about 40 feet across, from which, doubtless, much of the earth of which the mound is composed was taken. Within 60 feet of its western edge the ground begins to decline to form the ravine which carries the water from the adjacent praries to Haw Creek.

The mound had been dug into before, by whom I do not know, and I think nothing was found—at least that is the report. I cleaned out the former excavation, which was in the center, and about 4 feet across, enlarging it to 6 feet, carrying it at least 2 feet deeper, or 2½ feet below

the general surface of the soil, and thence ran a trench 6 feet wide towards the west 10 feet. The composition of the mound from surface down was as follows: thin layer of humus; then yellow clay and humus mixed, becoming more largely mixed with humus as it reached the level of the surrounding country, this layer being 2 feet 10 inches; then a thin, light colored layer one-half an inch to an inch in thickness, which I suppose to be ashes of grass and leaves, as there was no sign of charcoal in any part of the layer; then a layer of a few inches thickness, similar to the surrounding soil; then a firm yellow clay, that had no appearance of having ever been disturbed. The ash layer was undermined to the extent of two feet on each side. It was found to lie horizontally and at about the level of the surrounding ground. Nothing else was found.

No. 2, on the southeast quarter of the northeast quarter section 16, township 11 north, range 2 east, Knox County, Illinois, is 36 feet across, and on the east side of a ravine that runs into Court Creek from the north. The land is lightly timbered. A quarter to a half a mile nearer Court Creek, however, there are some fair-sized trees (2 feet). The ground immediately surrounding has hazel brush and scrub oaks, black-jack, &c. In height the mound is similar to No. 1. Its envelopes are similar, but the ash layer contains decided traces of charcoal. Nothing found by a very positive excavation carried to the depth of  $3\frac{1}{2}$  feet below level of surrounding surface. In the fields around for a quarter of a mile a great many arrow-points have been found. The twenty-eight nearly or quite perfect ones sent in package to the National Museum were found within this area.

To the north and a little to the east, about 100 rods, there is a very high point of land, from the summit of which an extensive view may be had of the surrounding country. This hill is and has been for thirty or forty years under cultivation, and upon it arrow-points in large numbers have been found. There are places on it where the ground is white with flakes and chips of the same material as the arrow-points. The stone hatchet of Witterell's collection was found about 40 rods east of the top of the hill. Between this point and where the hatchet was found, the old trail running from Maquon, on Spoon River, to Henderson Grove, on the head of Henderson Creek, was easily recognized thirty years ago. Upon the eastern slope of this hill and upon both sides of the old trail, and upon the south slope, towards the mound, are found numerous deposits of small, mostly flat-faced stones. The stones are found now but 2 or 3 inches beneath the surface. These are so placed that their flat faces are on the same horizontal plane, and cover a space of a foot or two, with intervals of a rod or two between them. Many of them are reddish, as if some ore of iron might enter into their composition, which upon being heated had become changed to red. The stones present other appearances of having been subjected to the influences of fire.



*Trails.*—Thirty years ago there were three distinct trails running across the country. One ran from Maquon, on Spoon River, to Henderson Grove; thence, in a northerly direction, to Galena, on the Mississippi. Another from the mouth of Court Creek, on Spoon River, to the same points. A third trail ran from Maquon north to strike the trail from mouth of Court Creek to Henderson Grove. These two trails met in township 11 north, range 3 east. Along these routes all the specimens sent you were found. Maquon was an Indian settlement on Spoon River. Here, within the memory of our oldest settlers, they had a village, and lived from year to year. There is an old Indian cemetery at this point and another at the mouth of Court Creek. Near the south line of Knox County, half a mile west of Spoon River, there is a group of three mounds, not yet examined, and half a mile further south, in Fulton County, there is another group of three, none of which have been explored.

## DESCRIPTION OF A GROUP OF MOUNDS IN BUREAU COUNTY, ILLINOIS.

BY A. S. TIFFANY, of *Davenport, Iowa.*

The group of eight mounds described below and represented in the accompanying plan is situated near Bureau, in Bureau County, Illinois, on the bottom lands of the Illinois River and Bureau Creek.

The land on which they are located has been farmed about forty years, and the smaller mounds have been considerably reduced. Numbers 1 to 3 are situated on a natural swell, and the diameters can be determined only approximately. These three were explored by the writer and Mr. Sale.

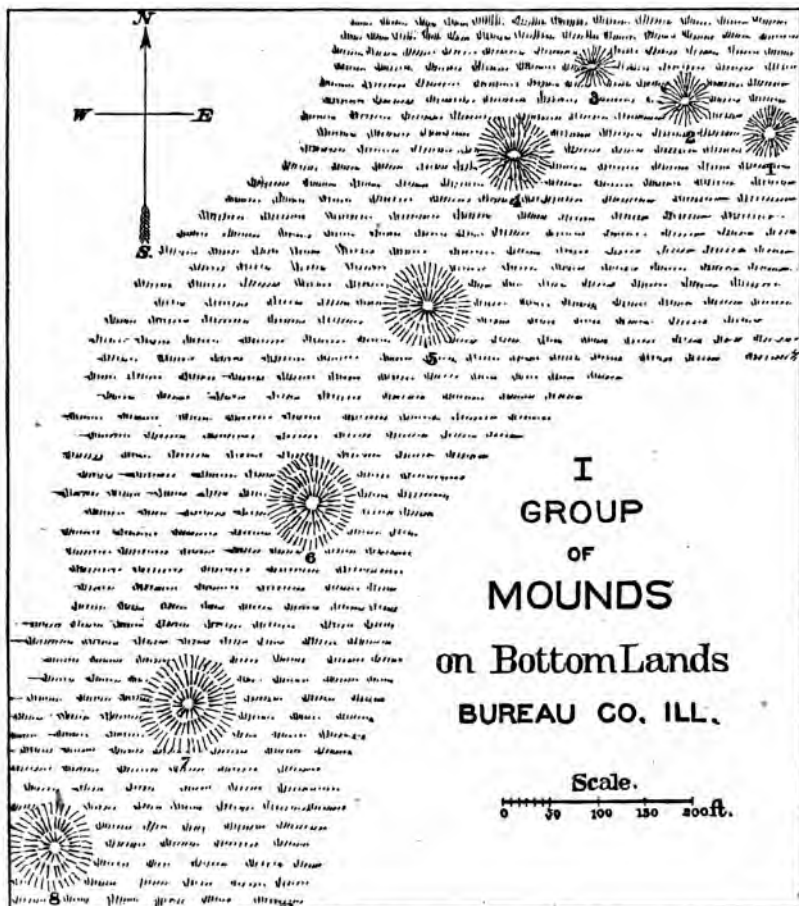
### *Dimensions and distances of the mounds.*

No.	Diameter		Height.	Directions.	Distance.
	<i>Feet.</i>	<i>Inches.</i>			<i>Feet.</i>
1	50	30	W. 20° N. to No. 2...		90
2	50	30	W. 20° N. to No. 3...		100
3	50	30	W. 45° N. to No. 4...		120
4	70	36	S. 40° W. to No. 5...		185
5	80	48	S. 25° W. to No. 6...		240
6	70	42	S. 25° W. to No. 7...		240
7	90	66	S. 25° W. to No. 8...		210
8	80	48			

A rectangular opening, 7 feet square, was made in mound No. 1. At a depth of 15 inches a bed of ashes several inches in thickness was reached, which extended in all directions beyond the opening. At a depth of 5 feet a few bones, much decomposed, were found. They were parts of two individuals. A small number of bone awls were lying near them.

A slight dip in the floor of the mound was observed in the northeast

corner. The exploration was extended 9 feet further, making the entire length of the opening 16 feet. The remains of two individuals were found with their heads toward the north. Under the head of the individual lying upon the west side was discovered a porphyry crescent-



shaped implement of rare beauty. It is polished on both sides, and all its edges are nicely wrought. The perforation does not extend through the stone, being only .55 inches in depth, but sufficient for mounting. A flint knife was deposited with the same individual, about where the right hand would naturally be.

At the northeast corner of this excavation, with some decomposed bones of the other individual, a bone awl or needle was recovered, about four inches in length, but a portion had been broken off. It was gracefully tapering and finely pointed.

A few pieces of pottery obtained were of the same character as that which occurs universally in this region. The crania were too fragile to

be saved. A few unio shells and water-worn pebbles had been deposited in different parts of the mound.

In mound No. 2 the skeleton of a youth, much decomposed, was all that rewarded our labor.

In mound No. 3 no human remains or objects of interest occurred.

The second group of mounds surveyed are situated on the bluff at Bureau, Bureau County, Illinois. The measurements are given in the accompanying table:

No.	Diameter.	Height.	Angle.	Distance from center to center.
	<i>Feet.</i>	<i>Inches.</i>		<i>Feet.</i>
1	18	18	S. 20° W. to No. 2 ..	18
2	21	30	W. 20° S .....	33
3	21	20	S. 40° .....	120
4	30	40	W. 20° N .....	50
5	30	36	S. 40° W .....	130
6	21	18	S. 40° W .....	250
7	30	30	S. 20° W .....	150
8	36	36	S. 40° W * .....	75
9	24	30	S. 40° W .....	39
10	21	15	N. 20° W .....	80
11	25	12	S. 30° W .....	24
12	24	24	W. 20° S † .....	66
13	27	20	S .....	49
14	30	24		80
15	24	30	E. from No. 13 .....	30
16	25	20	S. 10° E .....	45
17	24	20	W. 20° S .....	57
18	27	30	S. 20° W .....	80
19	18	10	S. 20° W .....	24
20	24	27	S. 20° E .....	27
21	15	10	S. 20° E ‡ .....	30
22	27	48	S. 40° W .....	80
23	24	15	S. 20° E § .....	24
24	24	24	S. 10° W .....	78
25	20	24	S. 10° E .....	to No. 25

\* Explored; pebbles, cedar wood, decayed, and coal; one skull.

† Oak stump; 160 annular rings.

‡ Oak stump; 450 annular rings.

§ Large white-oak tree.

## MOUNDS IN SPOON RIVER VALLEY.

BY W. H. ADAMS, of Peoria, Ill.

On what is usually termed a hog-back, on the north side of the Spoon River, 75 yards distant, 80 rods west of the east line and 20 rods south of the north line of section 12, township 11 north, range 43 east of the fourth principal meridian, is a round mound about 30 feet in diameter. On the highest point of the hog-back, at the surface, is some evidence of fire. The evidence of a former fire increases very rapidly. At a depth of from 12 to 16 inches five skeletons were found, of which nearly all the bones were calcined, and many of them entirely consumed by the fire. One of the skulls lay to the north, one to the northwest, one to the south-

west, one to the south, and one to the northeast. With the bones were fragments of sandstone burned red; at or near each skull, and nearly on a line between the point of the shoulder and ear, was a water-worn

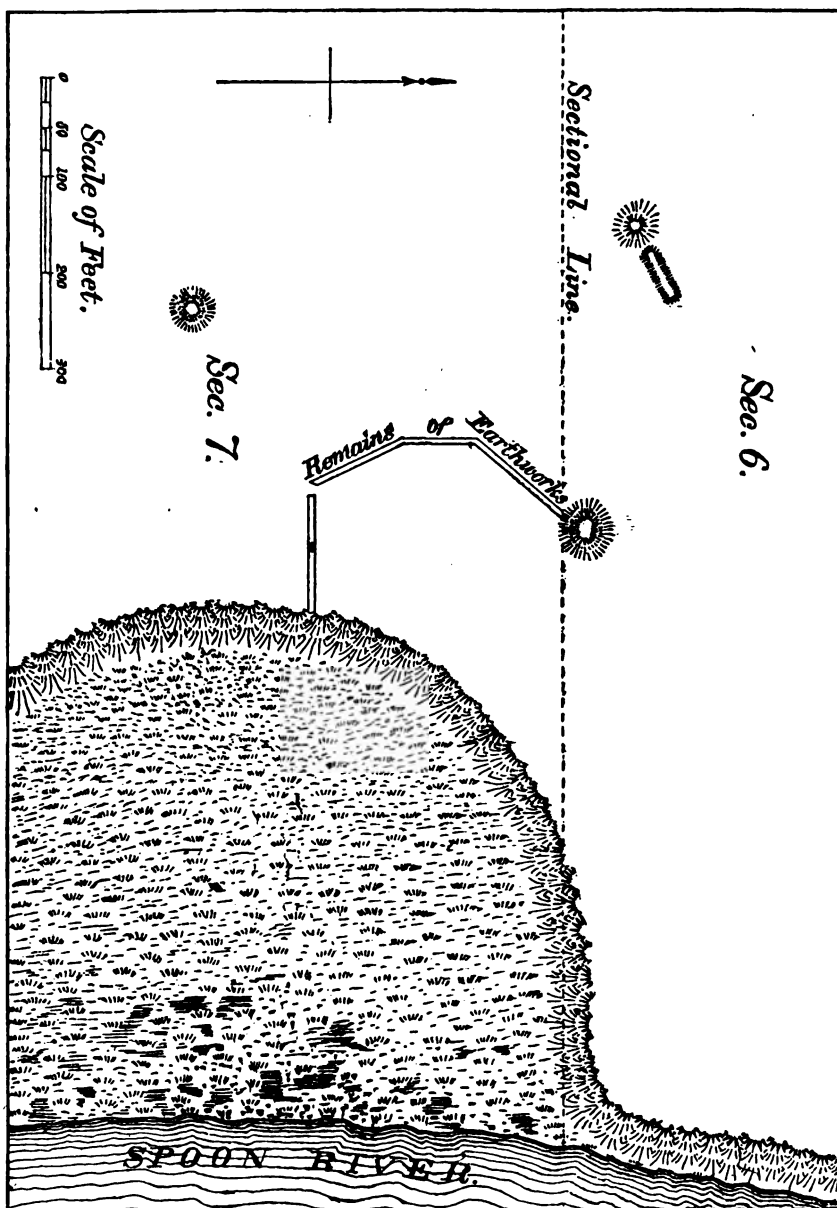


FIG. 1.

pebble, except in one instance, and in that it was an angular piece of flint. The pebbles had not been acted upon by the fire, so that they must evidently have been placed there after the intense heat had sub-

sided. From the appearance of the earth one would be strongly inclined to believe that the fire in this instance had been one of unusual intensity. From the position of the skulls with reference to one another, the feet of one body would reach to the head of the next, if laid at full length. One of the skulls was rather thinner than those we usually find in other mounds. Some of the teeth evidently belonged to a person of great age, while others were very small, but I cannot say that they belonged to an infant. The skulls were in fragments, the largest piece obtained being about 2 inches square.

On another hog-back, east of the one described, commencing on section 12, township 11, range 4 east, and extending across the northwest corner of section 7, township 11, range 5, and also some distance on section 6, township 11, are thirteen common round mounds, varying in height from 18 inches to 5 feet. As far as examined these are burial mounds, and nineteen skeletons were found in one of them. This mound was 45 feet in diameter and 5 feet high. The bones in it were in a fair state of preservation. I opened four or five of this group, and in each were found pieces of trap-rock from  $1\frac{1}{2}$  to 2 inches square, pieces of burnt sand-rock, and small water-worn pebbles, which I suppose to be jasper or something of that character, and in the largest mound was discovered a very small fragment of red pottery.

On the high bluff between Spoon River and Walnut Creek, on the south line of the southeast quarter section 6, township 11 north, range 56, are three mounds of some importance. The first is a common round mound,  $3\frac{1}{2}$  feet high, with a base diameter of 40 feet. This mound is three rods north of the sectional line between sections 6 and 7, and 60 rods west of the east line of section 6. (The land is owned by Henry Jaques.) I opened this mound at the apex, and at a depth of 2 feet found quite an amount of ashes, also one piece of trap-rock of irregular shape, and about the size of a small boy's head; also a honestone arrow point of the leaf-shape pattern. Eight feet east of this is a mound 62 feet long and 19 feet wide, with the greatest length from southwest to northeast. I made a cross cut of this mound at the middle, and in the center found a bed of charcoal, 10 inches deep, intermingled with ashes. I also made an opening near the east end and found nothing. Twenty rods east of this, on the sectional line, is an oblong mound, measuring 64 feet from west to east, and 47 feet from north to south, with an apparent height, above the surrounding level, of 3 feet. I made an opening in the center of this mound,  $4\frac{1}{2}$  feet in diameter, and at a depth of 2 feet I found some ashes and fragments of stone which had been polished, and 3 inches of yellow clay. This clay has the appearance of having been rammed or packed while in a plastic state. Below the clay is a thin stratum of red paint, and below the paint were ashes and paint intermingled. In this material were found fourteen arrow points made of honestone, all of the leaf pattern except one, and this was  $3\frac{1}{2}$  inches long, with notches at the base, and had the appearance of having been used;

also a small piece of galena was exhumed. There was a slight depression on the surface above the deposit. I made an opening 9 feet east of the center, in which was obtained a copper awl or needle  $3\frac{1}{2}$  inches long, and three-sixteenths of an inch square, thick in the middle, and sharp pointed at each end. This copper implement was inclosed in some material, which, under a microscope of low magnifying power, has the appearance of being the bark of a tree. This tool lay with the points southwest and northeast. I also found a white-flint spear-point or lance-head, 4 inches long and  $1\frac{1}{2}$  inches wide, without notches at the base. We found the flint implement about 10 inches southwest of the copper. This was surrounded by the same red material as the first. We first made an opening 14 feet west of the center of this mound, and at a depth of 3 feet 8 inches we found one copper needle or awl, rounded and pointed; three copper beads one-quarter of an inch in diameter and three sixteenths of an inch in length; one piece of copper tubing or bead 1 inch in length and one-quarter of an inch in diameter; one piece of tubing or bead three-sixteenths of an inch in diameter and 1 inch in length; one piece  $1\frac{5}{8}$  inches in length and one-quarter of an inch in diameter; and five other pieces very much like those described; also a small fragment of a tooth supposed to be human, and several small flint pebbles.

There are traces of a breastwork or fort, commencing at the southwestern part of this mound, about 6 to 12 inches in height. Commencing at the mound it extends southwest 120 feet, thence south 67 feet, thence south-southeast 106 feet, thence to bluff of Spoon River 130 feet (the bluff is 40 feet high), from the mound to the bluff in a straight line southeast 186 feet.

All the arrow points were finely finished, and far superior to those found on the surface of the ground. This mound is 42 rods west of Spoon River. The bluffs here are composed of the usual yellow clay, and contain very little sand. On the northeast corner of the northwest quarter of the southeast quarter section 5 are three common round mounds, standing in a triangular position to each other, with the largest to the north, the next in size directly south of it, and the smallest to the east, somewhat like the following figure:

On or near the southwest corner of section 4, township 11 north of the base line 5, east of the fourth principal meridian, are a series of common round and long mounds of more importance than any other yet discovered in this part of Illinois. (See Fig. 2.) Commencing at a point near the foot of a long bluff sloping to the south, and 40 rods north of the south line of section 4, and 10 rods east of the west line, are three common round mounds. For convenience we have numbered these, commencing with the most westerly. The distance is reckoned from center to center of round mounds, and from end to end of long mounds.

From 1 to 2 is 39 feet from center to center, from 2 to 3 is 30 feet from center to center, from 3 to 4 is 50 feet from center to center. This last mound is 80 feet long, with a cross mound at the center 33 feet long, 2 feet high, and 10 feet wide. The principal mound is 15 feet wide.

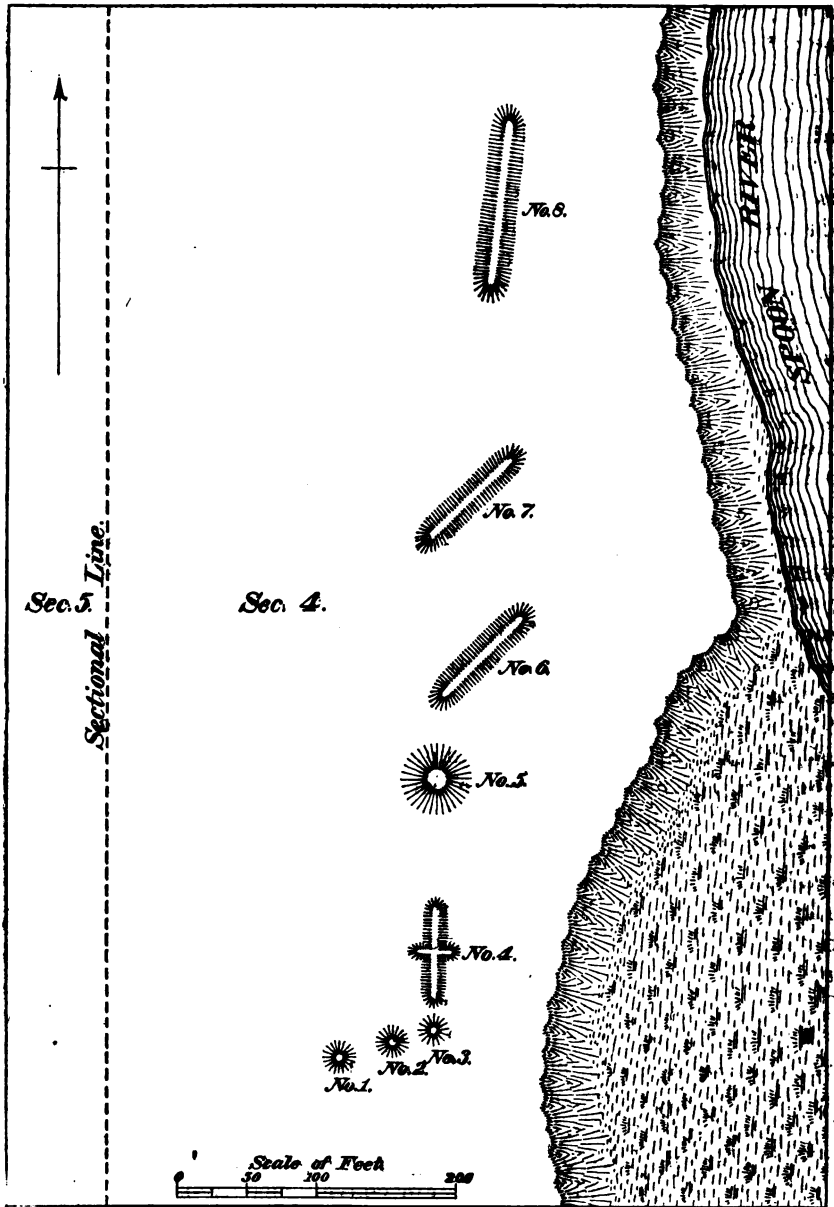


FIG. 2.

From No. 4 to No. 5 is 123 feet. No. 5 is a common round mound, 3 feet high, with a base diameter of 40 feet. No. 6 is 53 feet from No. 5, 98 feet long, 2 feet high, and 18 feet wide, with the greatest length from

southwest to northeast. No. 7 is 75 feet west-northwest of No. 6, and is 104 feet long,  $2\frac{1}{2}$  feet high, and 18 feet wide, with the greatest length from southwest to northeast. No. 8 is 100 feet from No. 7, and is 140 feet long, 3 feet high, 20 feet wide. Fifty feet from the south end of this is a black-oak tree, 3 feet in diameter, standing in the middle of the mound. (In accordance with the usual rule in this vicinity of computing sixteen growths to the inch, measuring on one side of the center, this tree was nearly three hundred years old.) This mound is 100 feet west of the bluff of Spoon River. The bluff is 40 feet high at this place, and very precipitous. In company with Mr. W. J. Morris, I made a cross cut in this mound to the original soil. At every spadeful we would bring up flint chips, and we found several pieces of trap-rock, some of them being polished on one side. Around the mound where the surface is bare great quantities of flint chips are picked up. We made a slight examination of Nos. 6 and 7, and found nothing, excepting traces of ashes and charcoal. On opening No. 3, at a depth of 2 feet, we found ashes; at  $2\frac{1}{2}$  feet, 6 to 8 inches of charcoal and ashes; at 3 feet, hard-packed earth; at 3 feet 3 inches, two skeletons, all the bones very much decayed, except the teeth, and these were not worn, showing the owners to have been not over thirty years of age. We opened Nos. 1 and 2, and found nothing. All the mounds appear to have been built at the same time, by the same people.

Spoon River at this point is 100 feet wide. We found no depressions whence the material of which these mounds are built was taken.

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## BURIED FLINTS IN CASS COUNTY, ILLINOIS.

BY J. F. SNYDER, M. D., of *Virginia, Ill.*

Prof. Joseph Jones has well said that "the fabrics of a people unlock their social history; they speak a language which is silent, but yet more eloquent than the written page."

To every thoughtful person there is a peculiar interest in the remains of nations that have fulfilled their destiny, and passed away; and this interest grows to fascination when studying the works of art, however rude, of people who have disappeared, and left no other legible records of their history and characteristics.

The origin and language of the prehistoric occupants of this region may remain forever unknown to us, and their color and personal appearance be only conjectured; but their implements, utensils, and ornaments, which have escaped the ravages of time, when properly interpreted, repeople our hills and prairies with their ancient inhabitants, and tell us, in language as plain as the written page, the story of their domestic pursuits and arts of life; of their customs, superstitions, and habits of thought.



In this view it is important that all discoveries of the remains, either of the works or the skeletons, of the aborigines, it matters not how insignificant, apparently, or how similar in kind they may be, should be carefully noted and accurately recorded, as each may possibly increase in some particular our knowledge of the primitive American tribes, or serve to confirm anew some fact of their history already known. Every stone implement, shell or bone ornament, and earthen vessel recovered, is a silent revelation of the past; and from this accumulated material the restoration of ancient life upon this continent is becoming annually more and more distinct.

It is well known to have been the custom of pre-Columbian Indians, as of their descendants in later times, to hide in the ground, for security until again wanted, stores of surplus provisions, and such implements and other articles as were not immediately needed or easy of transportation. Many of these buried stores of perishable materials, forgotten, or from other causes never recovered by their owners, soon totally disappeared; but others, consisting of objects wrought in stone, bone, and shell, are yet occasionally discovered in all parts of our country previously inhabited by the red race. These deposits are all full of interest, and some are wonderful for the surprising numbers, or weird beauty of design, or marvellous forms of the strange things they comprise.

Within the limits of this county two small subterranean long-hidden stores of flint implements have been recovered by the plow during the last two years. In the alluvial soil of Central Illinois, so destitute of surface rock, a stone of any kind turned up by the plow is of so rare occurrence as to at once attract the attention of any plowman, but unfortunately many valuable specimens so found excite but momentary notice and are again lost.

In the spring of 1880, Mr. George W. Davis, an intelligent farmer residing in Monroe precinct, 10 miles east of the Illinois River, when plowing one day in a field that, until a few years ago, had been covered with a heavy growth of timber, observed in the furrow his plow had just made a few sharp-pointed flints, and stopping his team to secure them, he found on examination that they formed part of a deposit consisting of thirty-two small implements, which had been carefully placed in the ground, on edge, side by side, with their points toward the north. They seem to have been buried near the foot of a large oak tree long since prostrated and decayed. This spot was on the crest of the ridge bounding the valley of Clear Creek on the south, and half a mile distant from a corresponding elevation on the north of the little stream, known locally as "Indian Hill," so called because the skeletons of several (supposed) Indians with stone implements, bone awls, glass beads, &c., were some years ago disinterred there in the process of grading a public road.

The thirty-two implements were presented to me by Mr. Davis. With one exception they are made of a cherty, muddy-looking siliceous

stone, of grayish color streaked with white; a flinty formation occurring in all lead-bearing strata of Illinois, and identical with the cherty nodules and seams very common in the sub-carboniferous outcrops of the upper Mississippi and southwest Missouri. They had been buried new, showing no marks of having been used, and their peculiar style of workmanship and similarity of design leave but little doubt that they are the product of the same artisan. The exceptional one in the deposit is a well-proportioned and perfect spear point, nearly 3 inches in length, neatly chipped from opaque, milk-white flint, strongly contrasting in material, shape, and finish with the others, and evidently manufactured by some other hand, perhaps in a different and remote workshop.

Fourteen of the lot are of the laurel leaf or lanceolate pattern, pointed at one end and rounded at the other, with edges equally curved from base to point, averaging three-eighths of an inch in thickness in the mid-



FIG. 1.

dle and evenly chipped to a cutting edge all around. They are uniform in shape, but differ in size; the smallest measuring  $2\frac{3}{4}$  inches in length by  $1\frac{1}{4}$  inch in width at the center; and the largest one is 6 inches long and nearly 2 inches wide. These fourteen are of a type quite common in all parts of the Mississippi Valley, and are supposed to have been used as *knives* or ordinary cutting tools. In our collection are six of these supposed knives, taken a few years ago from a deposit of over four hundred in West Virginia, and very similar in material, pattern, and dimensions to the fourteen now before me.

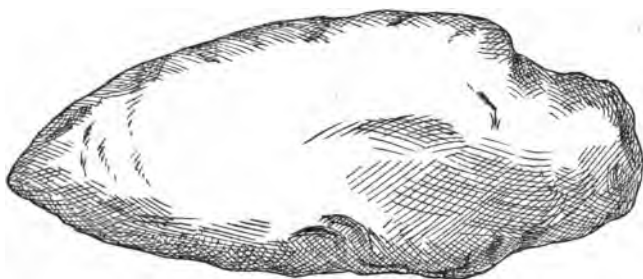


FIG. 2.

The remaining seventeen are shaped alike, but also differ in size as the first do, and are of the same average thickness. They too are sharp pointed at one end, but in outline from base to point their sides are un-

equally convex, one being considerably curved and the other curved but little from a straight line, giving them an ungainly and lop-sided form. Their broad ends, originally rounded, probably, like the first fourteen, have been chipped away on each side for half or three-fourths of an inch from the extremity, forming a broad rudimentary shank. At first glance these objects would readily be mistaken for unfinished awkwardly shaped spear-heads; but slight examination proves them to be completed implements, all fashioned after exactly the same pattern, with one end pointed, a greater convexity of one side than the other, and the base which in the first fourteen is regularly rounded, in these has been slightly cut away on each side, perhaps to facilitate their insertion in some sort of handle. The greater rounding out of one side than the other in all cannot be accidental, or due to want of skill in the workmen who made them; and this odd design is not easily reconciled with the ordinary forms and uses of spear points. Occasionally flint arrow-points

are found approximating this shape, one side from point to shank describing a slightly curved or straight line with the other side regularly barbed, or curved, as in the common types. In our collection are two specimens somewhat concavo-convex, or sickle-shaped. It has been gravely suggested that implements of this form were so made, and intended for use, exclusively for spearing and shooting fish, on the hypothesis that the greater weight of one side of the flint, or its irregular form, would give the shaft to which it was attached, when launched, a curved direction, thereby overcoming the water's refraction of the solar rays, and cause the weapon to strike the real and not the apparent position of the fish aimed at. In order to test this idea I made several experiments with the abnormally shaped flints. Securely fastening the one-barbed arrow-heads in straight, perfectly made arrows, I shot them with a strong sinew-backed Indian bow, at marks in the water and in the air, and found in every instance that the deformed flint had not the least tendency to deflect the shaft from its direct course. I then inserted some of the lop-sided implements from this Clear Creek deposit in light javelin shafts 5 feet or more long, and failed to discover the slightest deviation of flight when thrown either with much or little force in the air or in the water. The result of these experiments led me to conclude that the one-barbed arrow-points are merely weapons accidentally mutilated; and the most reasonable view of all the flints in the deposit now under consideration, save the intrusive white spear-point, places them in the general class of common cutting tools.



FIG. 3.

The second deposit of flints to which I have alluded was also turned up by the plow, on the 28th of March of the present year (1882), on the

southern border of this county, 26 miles east of the Illinois River. Its location was on the brow of the hills overlooking Indian Creek to the south, and in a field cultivated for the last ten years, but which had been cleared from a dense growth of large forest trees. In this *cache* were thirty-five elegant implements entirely different in form, material, and finish, from those before described. Their position in the ground was vertical and closely packed together, but otherwise without any peculiar arrangement. Axes and other objects made of copper, buried in the ground long ages ago by their rude owners, are now and then found, in many instances still encased in shreds of coarsely woven fabrics in which they had been carefully wrapped; the preservation of the matting or cloth being due to the salts of the decomposing metal. It is probable that the articles in all minor deposits, as the two here described, were also enveloped, when consigned to the safe keeping of the earth, in bark cloth or dressed skins, which, in the absence of antiseptic mineral oxides, have long since decayed without leaving a trace of their presence.

The thirty-five beautiful flints of this Indian Creek deposit are the perfection of ancient stone-chipping art. In form they are of the broad,

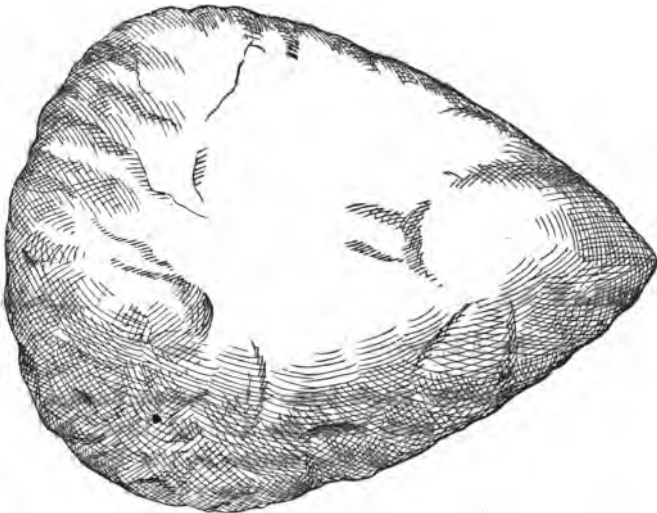


FIG. 4.

or lilac-leaf pattern, pointed more or less obtusely at one end and regularly semicircular at the other; the length but little exceeding the width; scarcely more than three-eighths of an inch thick in the center; they are smoothly chipped to an even sharp edge all around. They vary a little in size and somewhat in proportions, in the greater number the length exceeding the breadth by scarcely a third, while in a few, approaching the lanceolate type, the length is twice that of the width. The smallest of them is  $3\frac{1}{4}$  inches long by  $2\frac{3}{8}$  inches broad at the base; and the largest one measures 5 inches in length and  $3\frac{1}{4}$  inches

across the widest part. Six of them are made of mottled red and brown glossy jasper, and the remaining twenty-six of ordinary white flint, shading in texture from the compact translucent glassy, to the opaque milk-white varieties. In one of the neatest and most perfectly proportioned specimens the natural conchoidal fracture of the stone from which it was struck gives one side its exact contour without aid of any chipping. In several are embedded fragments of fossil crinoidal stems around which the siliceous atoms in solution or suspension first collected and solidified to form the rock; and in six there remain near the edges small patches of the buff, rind-like calcareo-siliceous outer coating of the flint-nodules from which they were split, not entirely removed by the process of manufacturing. The rounded edge of each is smooth and worn, and the sides of some are gapped, testifying to long and hard usage before their interment, and indicating conclusively that the broad circular edge of the tool was the one chiefly used. There is no reason to believe that these beautiful objects were used as weapons in any manner. Their pointed ends may have been inserted in handles of some description for convenience of manipulating them; but their crescent edges, so similar to the half-moon knives of modern curriers and other leather workers, forcibly suggest their use as skin-dressers. They are too fragile to have been serviceable in the scraping work of canoe-making, or in shaping any hard-wood or bone instruments; and could not have so well preserved their fine edges as hand-used agricultural implements, or clay-diggers for pottery making. Hence, I conclude that they were the *vade mecum* of the squaws, and their chief reliance in all their work requiring the aid of mechanical appliances.

## INDIAN REMAINS IN CASS COUNTY, ILLINOIS.

BY J. F. SNYDER, M. D., of *Virginia, Ill.*

Cass County fits into the angle formed by the confluence of the Sangamon, flowing from the east, with the Illinois River in its course to the Mississippi, a little west of the center of the State. It is not in the "forks" of the two rivers, but the one sweeps its entire northern border while the other bounds its limits on the west. Its topography is identical in main features with the most part of the great undulating prairie system of the State; and may be briefly described as a scope of open rolling land, studded with groves and furrowed with creeks and rivulets, and fringed all along its northern and western portions with ranges of bluffs which form the boundaries of the river valleys. Extending from the foot of these ranges of bluffs to the rivers lie the rich alluvial "bottoms" varying in width from 2 to 7 miles. Viewed from below the bluffs rise to the height of 150 feet in picturesque grass-covered peaks and ridges separated from each other by deep

wooded glens and gorges; and the bottoms, gently declining from the hills for half their width, are smooth as lawns, and now converted into the finest farms in the State, then reaching a lower level as they near the rivers, become heavily timbered and interspersed with numerous lakes and sloughs. Nature was here lavish in its supplies of fish, game, and wild fruits, and every condition necessary for the subsistence and endurance of a large population was present. This beautiful and fertile region, it is evident, was occupied by successive tribes from the earliest times before our history began down to the peaceable expulsion of the last of its dusky tenants, the Sacs and Foxes, during the administration of General Jackson. In testimony of this fact we have the relics of their remains, arts, and methods of life, which time has been powerless to destroy, in great profusion and full of fascinating interest. Of these silent records of a rapidly vanishing race the most important as well as the most legible are the earthen mounds which cover the bones and dust of their dead. They crown all the peaks and ridges of our bluffs, a few rising to considerable proportions, but the greater number are mere swellings of the surface not readily recognized as being of artificial origin. Every gradation of mound structure is here present, from the stately tumulus 30 feet in height to the broad, flat sepulchres so slightly elevated as to be scarcely noticed.

It would be useless labor and waste of time to attempt to locate on a map the situation of each mound or group of mounds in Cass County, and a tedious and unprofitable repetition to detail minutely the examination of each separate mound. For brevity of description they can readily be grouped in two or three classes, and the description of one will answer generally for all of its particular class. While in all of them, so far explored, the inclosed bodies of the dead were deposited on the surface of the ground, we find in some the position and arrangement of the remains to have been different from that found in others; from which we must infer that at times changes and innovations in mortuary customs were introduced, perhaps by different tribes who succeeded each other in occupancy of the country.

Of the first class of mounds, and by far the largest, and no doubt the most ancient, but one has yet been opened, and, unfortunately, no one versed or interested in ethnological study was present at the time to collect and preserve the relics it disclosed, or make any record of them. This mound, which I have before had occasion to mention,\* formerly stood immediately upon the bank of the Illinois River, within the present limits of the city of Beardstown, 6 miles below the mouth of the Sangamon. This locality is slightly more elevated than the surrounding river bottoms on either side, and was anciently an island surrounded on one side partly by the Illinois and on the other by a slough through which the river had once passed and yet discharged its surplus water. The island, on account of its peculiarly favorable position, had been for

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\*Smithsonian Annual Report for 1876, p. 438.

centuries a camping ground and stronghold of the aborigines. Geologically it, as well as most of the bottom, has a basis of loess or drift clay with a superincumbent stratum of sand 5 to 10 feet in thickness. All around the site of the mound the soil to the depth of 20 inches is composed of the *débris* of old camps, a mixture of ashes, mussel shells, bones of fishes and wild animals, charcoal, broken pottery, &c.; and here hundreds of implements of stone, bone, and shell have been obtained. The big mound is said, by persons who have often seen it before the hand of vandalism desecrated it, to have been more than 30 feet high by 150 feet in diameter at the base. Its summit commanded an uninterrupted view of the distant bluffs on both sides of the river and of the stream itself for 2 or 3 miles above and below. We can easily imagine the strange scene this great cone presented when it swarmed one autumn day with an eager, startled multitude of wild, half-naked barbarians gazing with astonishment at the sun-burnt, bearded faces and tattered garments of Marquette and Joliet as they wearily paddled their frail canoe up the quiet river at its base. More than thirty years ago the city authorities of Beardstown commenced the destruction of this splendid monument to utilize the clay of which it was composed for covering the sand of their streets, and in a few years the grand structure was totally demolished. The mound was found to have been made, on the sand, of clay taken from the bed of the river at low water or brought from the bluffs; and it had been used as a burying ground by people of different eras and races. Just below the surface the shallow graves and well-preserved skeletons of recent Indians, buried with implements of stone and iron and ornaments of glass and brass, were shoveled out; and a little deeper the spades uncovered the remains of a few Europeans, deserters, perhaps, from the commands of Chevalier La Salle or Lieutenant Tonti, who had found an asylum and graves among the Indians of this distant wilderness. There was one of them, however, whose mission in this part of the New World was widely different from that of his buried associates: the silver cross still grasped by his skeleton hand, the Venetian beads about his waist that had formed a rosary, and the ghastly skull still encircled by a thin band of polished silver proclaimed that here a self-sacrificing disciple of Loyola had expended life in the hopeless work of converting the heathen. These intrusive burials passed, nothing more was discovered until the original sandy surface of the island was reached, and what was there deposited before the great mass of clay had been piled over it was cast aside by the laborers without notice. From the street commissioner who had the work in charge I gained the following meager account of all that attracted his attention sufficient to impress his memory. Ranged along the middle of the structure was a parapet or wall, as he supposed, of rough flag-stones 30 inches high by 3 feet in breadth and 25 feet in length, designed apparently by the ancient inhabitants as a breastwork or rampart for the defense of their town from river approaches. But,

on removing the stones, it was found that this work of defense was not a solid wall, but a series of crypts or stone graves, constructed by planting broad, flat stones perpendicularly in the sand and covering them with others of the same kind laid across them. These rude tombs were entirely empty. Not a bone or tooth remained; so great was the lapse of time since the bodies of the honored dead had been laid in these secure vaults that not a vestige of them survived but blotches of dark dust upon the yellow sand. On either side of the primitive coffins, but not contiguous to them, were traces of fire, and with ashes and charcoal were noticed calcined bones, small cubes of galena, and broken flints and pottery. The destruction of the great mound yielded many rare and fine implements and ornaments of stone and shell, which no one thought to preserve; and no one thought to observe whether they had been interred with the dead at the base of the tumulus or with those buried upon its surface. Among the many relics unearthed, one particularly fine axe of polished stone is remembered, having a groove cut around the middle and a cutting edge on each end; also three pestle-shaped objects of beautifully polished porphyry 20 inches long,  $2\frac{1}{2}$  or 3 inches in diameter, rounded at one end and pointed at the other.

Seven miles east of Beardstown, up the Sangamon, and quite near it, at Mound Lake, is a conspicuous landmark known as "the Mound;" a ridge-like elevation 40 feet high by 60 yards in width, and 400 feet in length. This mound has never been explored, and may be of artificial origin; but I am strongly inclined to regard it a natural formation (like the great Cahokia mound and other similar elevations in the American Bottom), merely an outlier of the loess or bluff formation left there in the primal erosion of the river valley. It is situated in the edge of the timber, on the bank of a small lake, 3 miles from the bluffs, and in the midst of the finest fishing and hunting district, even in this day, to be found in Illinois. Whether or not the Indians raised this mound is a question to be determined by future investigation, but there is no doubt of their having used it as a place of resort and camping ground for a great length of time. Although it has been in cultivation for many years, traces of camp-fires are yet seen all over it, and its surface and the adjoining fields are yet littered with potsherds, flint chips, and decayed bones and teeth of wild animals. One of the very few entire pieces of pottery ever recovered in this county was plowed up with some human bones on this mound in the early history of its cultivation. It was a globular earthen vessel, 10 or 12 inches in diameter, marked externally as usual with the impression of the fabric in which it was moulded or sustained while drying. A similar vessel, but smaller, was plowed up unbroken in a field a few miles east of this place a few years later. At a point about midway the lake-side base of the mound I discovered, some years ago, the remains of a kiln in which the savages had burned their pottery. It was an excavation in its side, almost circular and 4 feet in diameter, an old-fashioned lime-kiln in miniature, with walls burned



as hard as a brick, and the bottom for the depth of a foot filled with ashes, charcoal, and broken pottery.

Nine miles farther east, up the Sangamon Valley and near the bluffs, is another large conical mound, 25 feet high, which has never been examined even superficially. These three mounds, assuming the latter two to be the product of human agency, are all of the first class, and of any class worthy the designation of mounds, found upon the river terraces or bottoms in the county.

The next class of mounds comprise those next largest in magnitude, and are more numerous than the first. They are invariably perched upon the peaks of the Sangamon bluffs, rarely exceeding 8 or 10 feet in height by 20 to 30 in diameter, and are more frequently met of much smaller dimensions. This class of mounds differs from all the others in the peculiar disposition of the remains they inclose. Too few in numbers to constitute the sepulchers of a distinct tribe with an exclusive burial custom, we must conclude that they cover the remains of a class of individuals distinguished from the commonalty for superior ability or merit. The mode of inhumation in mounds of this kind consisted in placing the body or bodies (for they contain from one to six or eight each) of the deceased upon the ground in a sitting or squatting posture, with the face to the east, and inclosing them with a rudely-constructed circular wall of rough, undressed stones, which was gradually contracted at the top, and finally covered over with a single broad stone slab, over all of which the earth was heaped. Though I have carefully examined several of these mounds, I have not yet succeeded in securing from them either an entire skull or earthen vessel, as their inclosed *cairns* are invariably found to have fallen in and crushed the bones and accompanying pottery into a confused mass. Nor have I discovered in them copper implements or pipes of any description, or any object of carved stone; but only a few flint and bone implements, and broken pottery without ornamentation and of very poor quality. Judging from every indication, external and internal, I would conclude that the class of earthworks under consideration were very old were it not for the singular fact that in one of them, a few years ago, the decayed bones of a single individual were found, with a few flint arrow points, a small earthen cup or vase, and an *iron* gun-barrel very much corroded.

The next class of mounds in this county are so numerous and were obviously constructed with so little care and labor that we must regard them as the depositories or cemeteries of the common and untitled dead. They are seen on every knob and ridge of the bluffs and on the hills bordering all of our smaller streams. Seldom rising in elevation more than a foot or two above the general surface, they frequently cover a space of 10 or 15 yards in diameter, and we sometimes find eight or ten of them in a row, along the crest of a ridge, separated from each other by intervals of 10 or 15 yards; each containing the bones of a greater or less number of individuals in different states of preservation. Their

repose is often rudely disturbed by the plow, and their human remains scattered over the fields with broken pottery and occasionally flint implements, stone axes, bone awls, and other relics. In many mounds of this class the first step taken in the inhumation of the corpse or corpses apparently was to scoop out from the soil a shallow, dish-like excavation in which the body or bodies—generally several together—were deposited, sitting up with limbs flexed upon the breast; they were then probably covered with bark or other perishable material, as no large stones are ever encountered in these graves, and then covered with earth. In some of them the bones of the dead, in extreme stages of decay, are in great confusion and were buried without definite arrangement or system, somewhat as was observed by Mr. Jefferson in a mound which he describes in his "Notes on Virginia," indicating that in those the skeletons of all members of the tribe who had died within a definite period of time had been collected from the tree-scaffolds, or brought from the tribal bone-house, as was witnessed by Bartram, and laid together in bundles and "covered with a great mound." The chalk-like softness of the bones in this class of mounds tends to confirm the first-thought impression of high antiquity; but this fact alone cannot be relied on as satisfactory proof of their age when we consider that the covering of earth, perhaps not of great thickness at first, has been washed down and thinned by rains, leaving the animal remains but slightly protected from the decomposing agencies of water and frost. In one instance unquestionable evidence of comparatively recent origin was presented. In cutting down a roadway through one of the Prairie Creek ridges, since known as "Indian Hill," in the southwestern part of the county, a broad, low mound was removed and the skeletons of several individuals exposed. With the mingled mass of bones thrown out were found broken pottery, a few stone and bone implements, together with a quantity of glass beads and brass rings of European manufacture. Resting in what remained of the hand of one of the female skeletons was a beautiful pipe of polished serpentine in the perfect form of a squatting frog, of life size, but instead of the usual flat, carved base of the so-called "mound pipes," it had an aperture drilled to connect with the bowl for the insertion of a cane or wooden stem. Some time afterward, at the foot of this ridge, the plow turned up a single skeleton from a mound so small as to have escaped previous notice; and so far advanced in decay were the bones that it was with difficulty I succeeded in partially restoring, by the aid of glue and plaster, the skull and facial bones. The only relics found with this individual, which I judged to have been a female, were a stone frog, probably unfinished, larger than the natural maximum size, without perforations of any kind, and a pipe, representing the head of a fox, both rudely cut out of soft, coarse, yellow sandstone.

In all the interments I have heretofore mentioned the bodies of the dead, so far as I could ascertain, had been primarily placed upon the

surface of the ground, or in shallow saucer-like depressions, in a sitting or doubled-up posture; or the dry bones, after decomposition of the flesh, had been gathered in bundles and placed on the ground in piles, and the earth heaped over them in a conical mound of greater or less magnitude. But in some, judging from the better state of preservation of the inclosed remains to be of most recent construction, a different arrangement is observed. The buried skeletons are found on the surface of the ground, but laid at full length on their backs, and surrounded or inclosed with thin broad stones or sheets of bituminous shale, stuck into the ground upright, and probably at the time of interment covered over with poles or bark before the earth was thrown on. This change in disposing of the corpse for burial was, in my opinion, a consequent innovation of the first contact with Europeans; and we have convincing reasons for believing that the old practice of burying the dead *above* ground in mounds of earth or stone prevailed generally among our Indians down to their acquaintance with the whites. Here, as elsewhere, we occasionally find the remains of Indians extended full length in graves *below* the surface of the ground, unmarked by mound or monument of any kind. These comparatively modern graves, copied after those of the white intruders, are, like the mounds, invariably on the high lands; and in many instances the crumbling chalk-like bones can only be identified as belonging to the red race by the implements of stone or shell ornaments associated with them.

Upon the open prairies of Cass County neither mounds nor graves of the pre-historic dead are ever found, and but few of their relics excepting flint weapons of the chase. The Indians no doubt hunted the deer and buffalo and elk on our prairies, but neither lived nor buried their dead there. Their camping-grounds and villages were in the groves along the streams and near springs, and they located their cemeteries upon the adjacent bluffs.

The southern line of this country in its entire length coincides very nearly with a small stream, called Indian Creek, which drains the prairies of a portion of Sangamon County, and, running almost directly west, joins the Illinois ten miles below Beardstown. This creek, too, was the resort of the hunter tribes, and along its banks are still traces of many of their camps and relics of their home life; and on the hills overlooking its valley are the low mound graves of their dead. On a high terrace sloping down to the water of this little stream I discovered, some time ago, the location of an ancient workshop for the manufacture of flint implements. The ground for a considerable space was littered with chips and nodules of flint and broken and unfinished arrow and spear points; and scattered here and there were several water-worn bowlders of granite and greenstone, brought from the drift clay of the hills for use by the early artisans as anvils. In this *débris* a beautiful polished celt of hematite and a few complete flint weapons have been recovered, together with bone punches and awls, and quantities of

broken pottery, ashes, charcoal, and fragments of shells, bones, and antlers of deer and elk. Only a few of the Indian Creek mounds have been critically examined, but there is no reason for believing that they differ in any essential characteristic with those of the Sangamon bluffs.

The remains of Indian art found in this country differ but little from similar objects found in all parts of the Mississippi Valley. The race inhabiting this locality before us left no specimen of their work indicating any expression of genius, or any marked degree of skill or proficiency in the common arts of life. The pot-sherds seen in profusion about their old camps and mounds are composed in the main of clay and lime (calcined muscle-shells), but a large proportion were molded from clay alone, and apparently formed parts of small rude ill-shaped and poorly burned vases and cups. The best specimens are ornamented with impressions of coarsely woven fabrics and bark of trees, curved lines, knobs, and indentations, and the marks of finger-nails. In no instance has there been noticed the slightest attempt to produce upon any piece of pottery the representation of the human face or figure, or of any bird or animal. But few of their earthen vessels have survived to the present time; besides the two pots found unbroken, which I have before described, not half a dozen have been secured entire in the whole county.

I have not yet heard of an implement or ornament of copper having been found among the mound remains of the county, and of hematite only the small celt before mentioned; two or three so-called "plummets," several "paint rocks" (or burnt pieces), and some rough blocks of the ore, constitute all of the relics of this material so far known. Occasionally with the bones of the dead are noticed small cubes of galena; and in our collection is a ball of this ore, taken from a mound, weighing a pound and two ounces, which probably did service, enveloped in raw hide, as some form of weapon. No lead, however, has here ever been discovered with any of the aboriginal remains. It is passing strange that the Illinois Indians, so well acquainted with lead ore as we know them to have been, should have never gained the knowledge of its fusibility and ready reduction to metal. Plates of mica are of comparatively common occurrence in our mounds, and in many instances are found to have been deposited upon the breast of the corpse. In one of the small ridge mounds of the Sangamon bluffs a skeleton was uncovered having upon the decayed sternum ten plates of mica uniformly cut to the dimensions of 9 inches in length and 4 wide, with the corners neatly rounded. This mineral is not found *in situ* in Illinois, and of course must have been imported from a considerably remote distance.

Of marine shells no entire specimen of the conch, or *Cassis*, or *Lycotypus*, has been seen in the old graves of our country; but small ornaments and beads made of the columellas and broken pieces of large sea-shells are quite frequently found. In our collection is a necklace comprising 178 pieces of conch shell—each perforated in the center and presenting all

stages of finish, from the rough angular sections two or more inches square, to the round polished complete disc two or three lines in thickness and from half an inch to an inch in diameter—which a short time ago was turned out of a low mound by the plow, with the skull and cervical vertebrae of a female skeleton. In another low mound on the bluffs the plow threw out, with a mass of chalky bones, a pint of small sea-shells (*Marginella apicina*), each pierced at the shoulder for the reception of a string to suspend them about the neck or hair. These beautiful little shells are often found in our mounds, and must have been in general use for personal adornment, or as a medium of exchange in the primitive system of commerce and trade. The valves of several species of fresh-water mollusks, especially of the *Unio* and *Anodontus*, were utilized as spoons and knives, and used for digging in sandy soil. Rarely we meet with ornaments cut from them. The hypothesis that our river mollusks constituted a part of the food-supply of the Illinois Indians is not sustained by the presence on our streams of shell heaps of any extent. Fish and game were abundant enough for subsistence at all times, and muscles were in this latitude evidently not considered a luxury.

The long bones of the deer, turkey, &c., were here as elsewhere fashioned into awls, needles, fish-hooks, and punches, and made to do service as handles for stone-tools and domestic utensils. The only ornament of bone (if it was an ornament) the county has yet produced is a broad, flat rib from the carapace of a very large snapping turtle, perforated at each end and ground smooth and polished all over.

Of objects carved in stone but few, besides the specimens I have specifically mentioned, have come to light in this county. Of pipes, a small "mound" pipe from Beardstown and the frog (of serpentine) are the only fine specimens known. In our collection are the fox-head pipe and several coarse, heavy affairs, without beauty or symmetry, which were undoubtedly used for smoking tobacco; and pipes made of clay and burnt are not uncommon. These latter objects were perhaps manufactured after the arts of the whites had been learned, as they are fashioned in the exact shape of common English clay pipes; at any rate, their resemblance to the imported article is so striking as to place their claim to high antiquity in serious doubt. As a rule, the objects carved in stone by the stone-age denizens of this region, exhibit such flagrant deficiency of taste or talent in design, and such low order of skill in execution, that we must conclude the few elaborate and finely-finished specimens now and then discovered here are importations from a distance, secured either by barter or reprisals in war, and were made by a people of higher intelligence and advancements in the arts. Of these exotic relics the porphyry "pestles," the "mound," and serpentine pipes, the perforated weapon of ribbon slate, a discoidal stone of milky quartz, and one of those beautiful perforated "ceremonial" stones of rosy, variegated, translucent quartz now in our collection, constitute all of that class known within the limits of the county. Agricultural flint implements, com-

prising spades and hoes, are not uncommon in the rich loamy terraces of our rivers, but are generally inferior in size and workmanship to those met with in that portion of Saint Clair and Madison counties known as the American Bottom. The spades are smaller and ruder, and the hoes are plain and without notches for fastening them to handles. The broad hornstone disks, discovered some years ago buried in the sand a short distance above the large Beardstown mound, and which I have described in a previous paper,\* are supposed by some archæologists to have been intended for agricultural tools, though never introduced in general use. Of this however we have no positive evidence, and until our knowledge of this class of relics is increased, we must regard that strange deposit as an unsolved mystery.

Celts and grooved axes of granite and various anagitic rocks, of all sizes and many patterns, have been, and still are, abundant here. The largest grooved ax in our collection weighs twelve and a half pounds; the smallest, one and a half ounces. Our largest celt, cut from a coarse-grained diorite, weighs eleven pounds; and the smallest, obviously a child's toy, weighs scarcely half an ounce. Flint arrow and spear points, knives, scrapers, and hatchets of the usual forms have been collected in Cass County in great profusion. Hammer-stones, nut-stones, discoidal stones, perforated "talismans" or "arrowstraighteners" of ribbon-slate, of basalt, and of fossil wood; stone-balls, plain and grooved; in short, all of the ordinary types of rough and polished stone implements in use by the pre-metal Indian tribes have been and still are often found about our streams and bluffs.

The archæological remains of which I have so far briefly treated are not peculiar to this county or to any circumscribed locality, but are common in all those portions of Illinois and of almost all of the Western, Middle, and Southern States contiguous to water-courses, where the aborigines, with identical habits of life and by identical methods, obtained, with little effort, their food-supplies. And the comprehensive generalization which I have attempted of the antiquities observed here will, with trifling variations and additions, apply equally well to those of other counties and States.

I have yet to mention, however, one object recently discovered in this vicinity, of rare occurrence in the prehistoric remains of this State, belonging to a class so suggestive of savage, ethnic characteristics as to incite interest and thoughtful study. On the crest of one of the highest and most prominent points of the Sangamon bluffs, jutting out from the range into the valley, a promontory, conspicuous for many miles in all directions, was one of the common oval swellings of the surface, usually known here as an "Indian grave," but so overgrown with bushes and weeds and tall grass as to have required close inspection to distinguish it from the natural contour of the hill. The owner of the land, having occasion to build a pasture-fence over this point, set a

laborer to digging holes for the fence-posts; but when the work had progressed as far as the "grave," the spade barely penetrated the sod at its edge, when it came in contact with a stone, which proved, on removing the soil covering it, to be a rough, flat sandstone flag, nearly square, 3 inches thick and 18 or 20 inches broad. It was thrown aside, and the fence completed. Some time afterwards, on learning that such a stone was found on this point, I concluded to explore the place with the hope of securing a skull or other relic of interest which it may have covered. Investigation soon convinced me that it had not formed any part of the covering of a grave, but had been laid flat on the bare ground. Carefully removing the bushes and earth in which they grew, other similar stones were uncovered, forming together a rude floor or pavement 12 feet in length by 8 in width, somewhat dish-shaped, the center being gradually depressed 10 inches below the edges. The stone first discovered had formed one of the corners of this curious structure. The long axis of the work coincided with the strike of the ridge, exactly north and south; and the flags of which it was made had been carried up from an outcrop of carboniferous sandstone a mile and a half distant, and were rough and uncut, but fitted together with surprising accuracy. They were reddened and cracked, apparently by long continued heat, and the interstices between them were compactly filled with fine ashes. Upon this pavement or "altar" was a mass of ashes, perhaps a foot thick in the middle, and a little more than filling to a level its basin-like concavity. On the surface of this ash-bed I collected fragments of charred bones, constituting parts of three adult human skeletons, among which were considerable portions of three lower jaws, with teeth intact, large pieces of six femurs and pelvic bones, the occipital protuberances of three crania, some bodies of vertebrae, and many small pieces so burned as to be unrecognizable. The fire which consumed these three skeletons had been smothered before it was exhausted, and while yet glowing, as many large pieces of charcoal were mingled with the bones, and the superincumbent earth in contact with the fire was reddened and partially baked. Interspersed throughout the mass of ashes filling the basin were many small pieces of bone and teeth converted into animal charcoal, and bits of flint, perhaps weapons, shattered and broken by the fierce heat of the pyre. I also observed many minute scales of burnt mica and shell, but found no part of any pipe or other object carved in stone, or of pottery. The mound inclosing this weird "sacrificial altar," after the washing of rains and beating of storms for centuries unnumbered, measured but little more than 2 feet high by 20 in diameter. The cracked and fire-scarred stones and great quantity of ashes without charcoal, mingled throughout with fragments of calcined bones, considered in connection with the prominent situation of the "altar," in full view of the valley below and of the highlands around for miles, seem to support the inference that here, at stated times, for a long period, had been practiced the burning

of human bodies; or that the remains of a great number of individuals had at one time been consumed until, with the three last victims, the fire was suddenly extinguished by heaping over the seething mass the earth that was to keep the story for the coming of another race. We are warranted in believing that all tribes of Indians inhabiting this great valley, from the remotest times, executed by burning certain captives taken in battle; but we have no evidence that dish-shaped platforms of stone were constructed especially for that purpose. The simpler method of securing the doomed wretch to a stake or tree and there slowly roasting him amidst the wild jeers and exultations of the captors is far more consonant with well-known Indian nature and usages. But for the absence of collateral testimony the hypothesis that so-called "altars" of this class were made for the purpose of incinerating, at stated periods, the remains of the dead of the entire tribe, collected for such disposal from tree-scaffolds or bone-houses, would present many elements of plausibility. It is possible that a single tribe may have so cremated the skeletons of their deceased kinsmen before making their voluntary or compulsory exodus from this locality; but observed facts fail to sustain the idea that such a mortuary custom prevailed here generally at any time or among any people. We have the authority of La Hontan that the Indians of the Lower Mississippi "burnt their dead, keeping the bodies until they had accumulated" sufficiently in numbers for the grand ceremony, which was performed in certain places remote from their villages. But Du Pratz, whose opportunities for observation and sources of information were equal if not superior to his, positively asserts that "none of the nations of Louisiana were acquainted with the custom of burning their dead." Had this custom been in vogue to any considerable extent or for any considerable period of time it is plain that cinerary altars would be numerous and sepulchral mounds exceptional. In Cass County and the State of Illinois, so far as my knowledge extends, this strange monument is unique and without parallel among thousands of Indian mound-graves, a mystic expression, it may be, of religious fervor or superstitious frenzy.

The intrinsic evidence of many prehistoric remains of this county sustains their claim to extreme antiquity, but no work or specimen of art of a former race has yet been found here above the capacity or achievement of the typical North American Indian. And in studying the life, habits, and burial customs indicated by these relics, I can see no necessity for ascribing them to the agency of a distinct or superior race, when they express so unmistakably the known status of Indian intellect.



## ANTIQUITIES OF JACKSON COUNTY, ILLINOIS.

BY G. H. FRENCH, *of Carbondale, Ill.*

Among the many objects attesting that Southern Illinois is part of a region once inhabited by a race of people about whom comparatively little beyond conjecture is known, the various mounds and cairns form a conspicuous part. The exploration of one of these structures was the subject of two visits by Dr. E. B. Chapin, a resident of this place, and myself on the 3d of April and the 3d of June, 1878. The mound is situated on the farm of E. M. Norbury, about 3 miles south of here, and is about 40 rods west from the Illinois Central Railroad, on a hill that forms a spur from a comparatively level area of land back a little from a creek on the south, and just in the edge of a piece of second-growth oak timber. Situated as it was on the point of this hill, it was difficult to judge at first of either its height above the natural ground or of its size; but subsequent examination showed that it was, in its highest part, about 3 feet above the original ground, and it appeared to be 25 or 30 feet in diameter. We found, however, that inside these limits was a series of stones that seemed to have been placed around the base of the mound to hold the dirt in position as it was heaped up, and as the elements in time had removed the dirt from the higher parts and spread it around and beyond these stones they had become partly or wholly covered up, while the extent of the structure was increased. If this theory is correct, and the position of the contents of the mound seemed to indicate that it is, the mound was originally oval or nearly oblong, and measured 12 by 15 feet in its shortest and longest diameters.

For 2 or 3 rods to the south and for 20 or more rods to the north and northwest, chips of flint were abundant, both mingled with the soil and on its top. The same soil and flints mixed with broken bits of pottery formed the general substance of the mound. These seemed to indicate that the immediate vicinity had been the site of an Indian workshop and perhaps camping ground. In the time when this ground was covered with the primeval forest the small branches only a few rods to the east and west would have afforded them water most of the year, if this locality ever formed a permanent place of abode; while the creek, from 50 to 80 rods to the south, would be the unfailing source when the heats of summer had dried up the others. Several other facts seemed to point to this as having been for them a central position. Across the creek, that is to the south, and 80 or more rods on the other side, in a southwesterly direction, was a stone mound that we also explored, but found no remains of any character either in or about it. It seemed to be simply a monument of direction as much as anything we could discover, an irregular cairn of stones in such a position that the natural contour of the land would indicate there might have been here

a trail, but all other marks are now obliterated. Still further to the south, but whose exact position I did not learn, are several other mounds, which I think have been more or less explored. To the southeast, at a distance of 5 or 6 miles, is a structure known now as "Stone Fort," that is supposed to have been constructed by the Indians, and probably for defensive purposes. This is, or evidently has been, a wall across the neck of a projecting point of rocks, though it is now but a long pile of stone as though a wall had been demolished. Northwest from this mound, some 12 or 15 miles west of Carbondale, are other mounds, while north or northwest of these are others, as though forming a line with those that have been found within the vicinity of East Saint Louis and Alton. All these facts seem to bear more or less directly on the idea that at some time this locality had been a place of general work and resort.

The central part of the mound had been more or less disturbed on top by having been a place where brush and other refuse had been burned, and where hogs had lain and rooted, but it was claimed by Mr. Norbury, the owner of the place, that other than this it had not been disturbed. As intimated before, the mound was composed of the natural black surface soil of the place mingled with chips of flint and broken pieces of pottery, the latter red, the flint of a blue kind, and in all shapes and sizes, but we found no arrow-heads or other implements of the same kind of stone. We found only one arrow-head, and that was of white flint, regular lanceolate shape and about 3 inches long. The pieces of pottery were all small and of irregular shapes. The only implement found, other than the arrow-head, was a thong-gauge, about 3 inches long by about an inch and a half wide, with two gauge-holes and a slight depression on one side between the holes as though a place for the thumb when used. This was composed of either red stone or pottery; I am inclined to think the first, as it seemed to be too compact for pottery, or at least more so than the broken pieces found.

In the northwest part of the mound was found a skeleton in a horizontal position lying on the back with the head towards the northeast, and about  $3\frac{1}{2}$  feet below the top of the mound. The bones were so decomposed that it was with difficulty that a whole one of any part of the skeleton could be taken out without breaking and crumbling, though while in position the shape of the skull indicated that it corresponded with those taken from other mounds at Sand Ridge, this county, and other points in the vicinity.

No other complete skeleton was found in the mound, though pieces of human bones representing nearly all parts of the skeleton were scattered through different parts of the structure, together with the bones of other animals. Of these we could recognize the lower maxillary of deer and the atlas of a bear, but the rest were too much broken to be identified. Besides these there were a few land-shells, a species of helix, and a few broken salt-water shells, perhaps of some species of unio. The scattered

human bones were all of them more or less broken, the breaking seeming to have been done when the bones were fresh. In one or two instances only were we able to find the different pieces of the same bone. In one case a femur was broken into threepieces, the head and two parts of the shaft, and these were 2 or 3 feet apart. It may be stated here also that these scattered human bones, the flints and broken pieces of pottery, together with the shells and bones of animals, were all of them above the depth where the skeleton was found, as though they were mixed with the earth of which the mound was built. We could account for this in the following manner: The chips of flint, shells, bones of animals, and the scattered human bones were on the surface when the burial took place, and after the body had been placed in position the dirt on the surface that could be the most easily obtained was gathered up together with whatever was scattered over the surface. Of this the mound was built, and, from what we know of the habits of the Indians of the present, it takes but little imagination to form a picture of the squaws gathering up this material in their baskets and carrying it to the place where it was wanted. This would imply that the people who did the burying were cannibals, and the broken character of the scattered human bones would in a measure substantiate that view.

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## A STONE FORT NEAR MAKANDA, JACKSON COUNTY, ILLINOIS.

BY G. H. FRENCH, *of Carbondale, Ill.*

In company with Prof. A. C. Hillman and Mr. John Martin, one of our students very much interested in natural history, I visited Stone Fort, near Makanda. This place is situated in township 10 south, range 1 west, of the third principal meridian, on the east side of the Illinois Central Railroad, and is about three-fourths of a mile, by road, northeast from the village of Makanda. The country here is very hilly and rocky, Makanda being situated in a gorge, through which the Drury Creek runs. North of Makanda, where the road turns east, is a side gorge, through which runs a small tributary stream of the Drury, more or less lined with rocky bluffs on both sides. The surface beyond the bluffs in some places slopes upward; at others the bluffs are nearly as high as the general elevation of the surrounding country. On the west of a bluff known as the Stone Fort another smaller stream comes down between the bluffs. It is now nearly dry but is well filled with water in times of freshets. Stone Fort is a ledge of rocks projecting out as a rounded point from the northern and eastern side of this second gorge, more toward the stream than the general course of the bluffs. On the southern face the bluff is 125 feet high. Across its neck above extends a pile of stone, running east and west, which gives the place its only import-

ance archaeologically. This pile of stone is about 280 feet long, and on an average 2 rods wide, and in the middle is about 30 inches high. The distance from the front face of the bluff to the middle of the stone wall is about 300 feet. The lengths were obtained by pacing, and the width and depth by tape-line. The middle of this inclosed space is from 15 to 20 feet higher than the edges, the slope being gradual. The whole space is covered with trees similar in size and appearance to those on the tops of the other bluffs. All around the bluff, from the front or south face to the east and west, the rocks are either perpendicular or overhanging; but on both sides back of the line of piled stone the top may easily be reached, as the distance from the summit of the bluff on its southern face to the more nearly level ground below decreases toward the north, being perhaps 50 feet at the eastern and 25 feet at the western end of the stone wall. This pile of stone across the neck of the bluff shows evidence of having been a wall. To see if there were any signs of regularity in its structure, and upon what base it had been constructed, we took out a cross-section of the stone in one place where they seemed to have been thrown down, and partial sections in several other places. First, the materials are sandstone, the same as that of the bluffs. Many of them are flat, all irregular, just as would occur in breaking up that kind of stone. In size they vary from some smaller than a man's head to those as large as one man can lift. They are built upon the ground and not upon the ledge of rocks, as the earth beneath the pile is the same as that constituting the top of the bluff, save that here there is no vegetable mold. Most of the larger stones are placed where was the base of the wall, seemingly with but little regularity. At the ends, where the hill is a little steep, the flat stones at the bottom are set on edge, and the next course so laid that its top surface would be nearly level, or sloping a little up the hill. This, of course, would make it easier to lay the succeeding stones. Where these stones came from is hard to tell. If there were only a few of them one might conclude that they were picked up from the surface of the inclosed area south of the wall and on the open space north of it. But there are not stone enough on the same area of the tops of the other bluffs to make such a pile. Part of them may have been obtained in that way and the rest brought there from above, where this bluff is not very high.

The question "why they were placed there?" seems to admit of but one answer—they were a means of defense. The fact that it has been known as Stone Fort ever since the country was settled implies that such has been the general opinion of the people acquainted with the place. It has been assumed, however, that it was the work of hunters for the purpose of a protection to their camp. I can hardly conceive that a party of hunters, for a temporary camp, would go to the trouble of gathering such a mass of stone as is represented in 280 feet long, 33 feet wide, and, on an average, 1½ feet high. It may have been the location of an Indian encampment in some former years, and built

by them as a protection from their foes, and used very much as Starved Rock, on the Illinois River, was by the Illinois Indians.

The question will occur, where did they obtain their water for domestic purposes? On the west side, just within the end of the wall, there is a deep, narrow fissure in the rocks, down which one man at a time might go; and it is only a few feet from the bottom of this fissure to the stream that comes down the rocks. Evidently there is always a little water here, and it is quite palatable, as we found by trial. This may have been their mode of egress and ingress to the inclosure.

We found very little remains of the former occupants. At one place beneath the stones, evidently just south of what was the south side of the wall, we found a broken arrow-head of white flint, the only relic discovered in the inclosure. We did not dig into the ground, either south or north of the wall, not seeing any elevation that looked like a mound. I would add further, in relation to the bluff, that the fissure just spoken of, inside the western extremity of the wall, is the only place where it is possible to reach the top from any point south of the wall.

That it was a place of refuge from any body of men using fire-arms does not seem probable, for the following reason: In addition to the evidence which the broken arrow-head affords, the bluff to the south, across the creek, is considerably higher than this one, and is within range of a rifle, but would not be within arrow-shot. This, and the fact that there seems to be no tradition of the building of the wall, would lead us to conclude that it antedates the white settlements of this region. It is not far from a number of Indian mounds to the north, or a little west of north, that seem to form a nearly continuous line with others still farther north. One of these mounds I opened in 1878.

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## ANCIENT REMAINS NEAR COBDEN, ILLINOIS.

BY F. M. FARRELL, *of Cobden, Ill.*

Along the range of sandstone bluffs that traverse Southern Illinois running eastward and forming the water-shed between the tributaries of Big Muddy River on the north and Cache River on the south, and from 16 to 20 miles east of the Mississippi River, I have been making a few discoveries which prove that the sheltered nooks formed by the projecting cliffs were the favorite abodes of an ancient race that once peopled the Mississippi Valley.

The first place investigated is 2 miles east of Cobden, Ill., under a projecting cliff of sandstone (millstone grit) about 60 feet high and facing the east.

Around an ancient fire-bed, not more than 1 foot below the surface, in a loose, porous clay, were found charred bones, flint chippings, fragments of arrow-heads of very rough workmanship, fragments of rude

pottery made of red clay, and fine gravel. The pieces were half an inch thick, or nearly so, and, judging from the curve, they may have been of considerable size.

One morning in March, 1880, a party of us went to the bluffs known locally as Buffalo Gap, a deep triangular hollow, inclosed on two sides by immense ledges of stone, towering high above the tree-tops, and projecting far over the base, and forming sheltered nooks which bid defiance to the storms of winter and the heat of summer.

All along the base of these rocks the ground is strewn with flint chippings, bones, bits of pottery, arrow-heads, rocks, and rubbish. We made excavations in several places, and to various depths, varying from 1 to 3 feet.

The earth is dry and loose, and composed of considerable vegetable matter, and has the appearance of having been forming slowly for ages. All through this dust we found bits of pottery, arrow-heads, charred bones, charcoal, bones split lengthwise to extract the marrow, mussel-shells, turtle-shells, deers' horns, bones and jaws of various kinds of mammals, a bunch of charred hay, a large limestone mortar, having a bowl nicely cut in the center, which was circular in form and 1 foot in diameter, and deep enough to hold about a gallon. On a fire-bed 2 feet from the surface were the fragments of an earthen pot, probably a cooking vessel, as it contained bones and a fragment of a deer's upper jaw; also other material, which we were unable to determine. Near this pot were numerous spherical bodies, resembling spice in form, white, hollow, and too fragile to be preserved.

The pottery has markings on the surface like the impression of grass, twine, and sometimes small sticks, showing that the vessels were molded in some kind of woven sack or basket made of willows and twisted grass. Some of the fragments were smooth and thin, the coarser ones one-half inch thick, and made of pounded mussel-shells, small gravel, and red clay. The shells which were found were probably brought up for that purpose, the animal having been used for food. The arrow-heads are rude and very poor compared with the field specimens of which I will speak later.

An old fort is near by, on top of a cliff, and cut off from the main land by a wall of stone, which is now nearly flat, covering a base 20 feet wide and about 150 feet long. The fort is triangular, the wall making one side and the perpendicular rocks below forming the other two sides. It had but one point of access from below, which is a path up a crevice in the rock, and could have been easily defended from above. This has the appearance of being very ancient.

Near the Illinois Central Railroad track, 5 miles north of Cobden, are other large bluffs, and underneath are numerous beds, which have afforded a great many relics. Several human skeletons have been unearthed, more or less preserved, though usually badly decayed, but one skull

(female adult) was nearly perfect; forehead small, domestic faculties largely developed. The body of an infant was found near this one.

Besides human skeletons, bones of a good many kinds, though mostly deers' horns and bones, bones split lengthwise, large numbers of mussel-shells, turtle-shells, broken pottery (some of which must have been large), a considerable amount of parched corn, and the impression in the earth of woven fabric, which is rare here. The arrow-heads are numerous but of a rude character. Several fine bone awls were found. This seems to be the richest locality yet discovered here.

Near Makanda, 3 miles north of this place, is an old fortification, called Stone Fort, as it has once been defended by a stone wall, which is now nearly demolished.

*Field relics.*—Near all large springs implements of stone are found more numerous than at other places. They are of fine workmanship usually, and of various forms. The arrow-heads are of flint, of all colors. Shovels from 4 to 15 inches long have been found. Celts are of green-stone, handsomely polished, from 3 inches to nearly a foot long. Green-stone hatchets, having a groove for a handle, are found of various sizes, and well made. I have two in my possession, weighing  $1\frac{1}{2}$  and  $2\frac{1}{2}$  pounds, respectively, though some found here will weigh probably 5 pounds.

*Workshops.*—Three miles west of Cobden, near Kaolin Station, on the Saint Louis and Cairo Railroad, is the most extensive workshop I have found. It covers several acres of ground, and car-loads of flint chips and boulders are strewn everywhere. Four miles south of Cobden is another of less dimensions. Others of greater or less size are met with in various parts of the country, but no relics of much value are found with them.

*Aboriginal burial.*—Seven miles west of Cobden, in Union County, Illinois, near Clear Creek, on the farm of Adam Smith, is an aboriginal cemetery. It is situated on a hillside facing the south. The graves are in a group, and were probably arranged according to some plan, but the spot has been in cultivation fifty years, and the graves are sadly mutilated. Each grave contains a single individual. The bodies were stretched out at full length. Of the two that were examined one was lying with the cranium to the west; the other toward the north; the face of the one toward the rising sun; the other facing the noon-day sun. The remains were inclosed in sarcophagi made of thin slabs of white sandstone, which were probably quarried from a ledge about three-fourths of a mile distant, in the bank of Clear Creek. The bones were (except the teeth) nearly decomposed. The graves were scarcely a foot beneath the surface, and mostly disturbed by the plow.

The mounds 7 miles below Jonesborough, Ill., have afforded many valuable relics, including numerous perfect water-vessels and other pottery, arrow and spear heads, celts, hoes, hatchets, pipes, skeletons, and one stone idol made of stalactite. These mounds have been investigated by F. M. Perrine, of Anna, Ill., who has a fine collection of mound and field relics.

## ANTIQUITIES OF WAYNE COUNTY, ILLINOIS.

BY H. F. SIBLEY, of *Fairfield, Ill.*

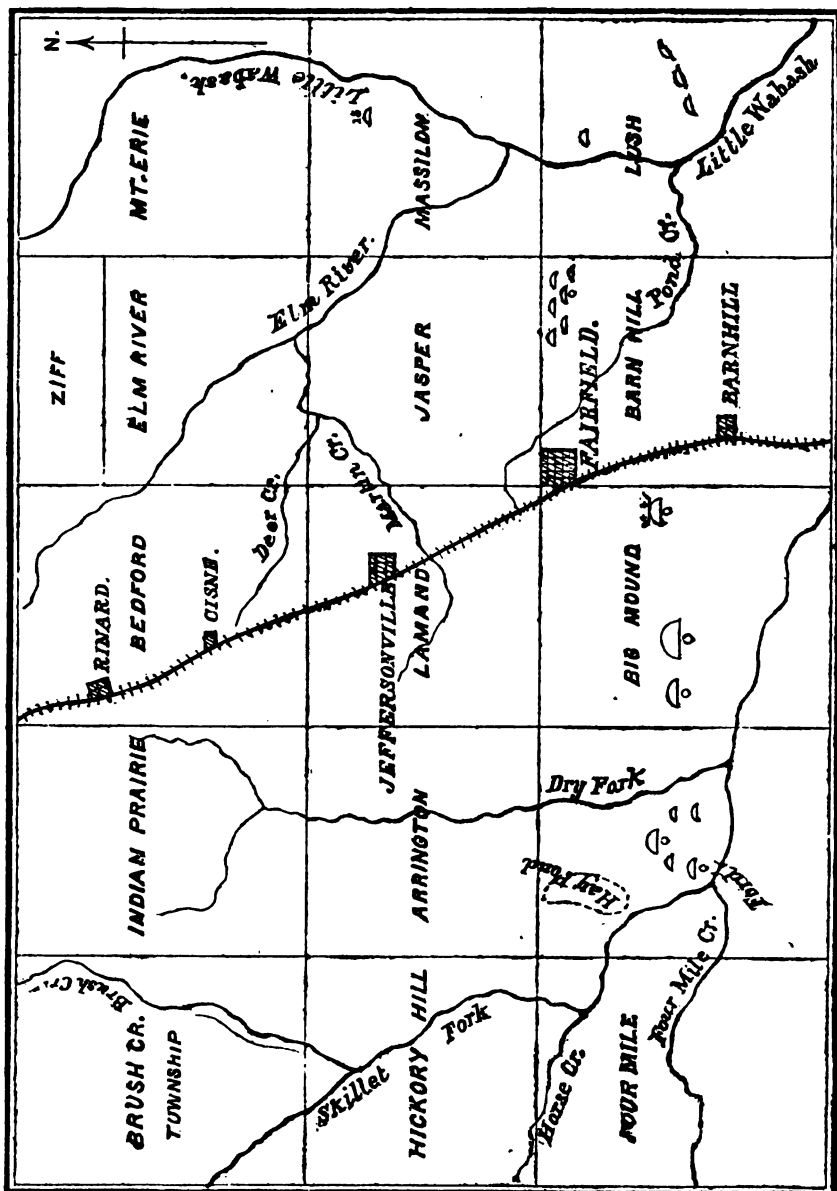
Wayne County is one of the larger counties of the State, located on the southern border of the prairie region. At least three-fourths of its surface was originally timbered land. The prairies are generally small. The principal streams are the Little Wabash and Elm Rivers and the Skillet Fork (a branch of the Wabash). The surface is generally rolling and elevated from 50 to 125 feet above the stream beds. The Wabash and Skillet Fork bottom lands are generally rather low and flat, with the exception of some few ridges of high land, ordinarily lying parallel with the watercourse. On the ridges generally we find the ancient tumuli of the Mound Builders. One of the most prominent places of ancient resort in our county was a ridge in the Skillet Fork bottom, now known as Fleming's Ridge, in Arrington Township. (See map.) The ridge commences at the river and runs almost due north to the prairie, and is from one-half mile to one mile wide. Near the south end of the ridge, about one-quarter to one-half mile from the river, is a group of mounds, seven or eight in number. Several farms have been opened up, and mounds are found all over the ridge. Two of them have been explored and the ordinary fragments of pottery, shells, human remains, &c., were found, but all seem to have been disturbed. Just to the southwest of the ridge I have drawn a half-moon-shaped figure for a pond, or rather where a pond had been, but which has been drained for the fish. It is now known by the name of the Horseshoe Pond from its peculiar shape. It was probably an artificial fish-pond built by the Mound Builders, as it fills up when the river is high, but can easily be shut up even during high water. Southeast of the ridge are two more mounds, about 100 feet long and 50 feet wide, and now 6 or 7 feet high. One of them was examined, and in it were found some flint arrow-heads (very rude), an immense number of turkey and wolf bones, together with deer-horns, &c., which seemed to have been thrown into fire, some of them being partially consumed. Human remains were also found, as well as some broken bits of pottery. There seemed to be no line of separation.

In the southwest corner of Big Mound Township are three mounds in one group which have never been examined. Northwest and near to them are two more, of which one was examined, and in it were found rude arrow-heads, broken pottery, &c., but could not get a skeleton in any state of preservation at all, so as to determine how they were buried.

On the east edge of the township, some 2 miles south of this place (Fairfield), are two mounds, one of which was slightly examined, and found to be a burial mound. One mile farther south, almost right in the center of Little Mound Prairie, is a natural elevation, topped out by



the Mound Builders into a cemetery that can be seen for a long distance. It was the burial-place of hundreds who are interred in the stone cists, of which numbers have been examined. Axes, arrow-points, &c., used to be found in abundance in the vicinity, but they are now



about all picked up. In Barnhill Township, 5 miles east of us, is a group of seven mounds, which have not been examined, but which were probably dwelling-places. They are small, about 90 feet in circum-

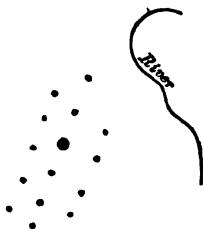
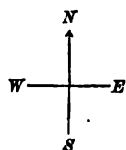
ference, and from 2½ to 3 feet high. In Leech Township, on the west side of the river, is a group of six mounds, which have not been examined; neither has the one which is on the east of the river at the Iron Bridge, where the stage road crosses the stream. About one mile east and one mile south of the bridge are three mounds, standing as shown on the map, one of which was examined, and found to be a burial mound. About 100 yards southwest of these mounds is a pit 10 or 12 feet square and 7 or 8 feet deep, and within 6 or 8 feet of the river bank. It has never been examined. One of the old men in the vicinity told me he had noticed it every year for a long time, and says it is not nearly so large as it used to be. Just below, at the mouth of the Pond Creek (on the west side of the river), is a square inclosure, said to be 100 yards or more square, called the Old Fort, but I have not seen it. In Massillon Township is a group of seven or more mounds, as shown on the map. It is a very high bluff, and has been a famous place for the ancient race. It is a good fishing and hunting locality, the river at that point containing a shallow rapid or riffle, and just across the river on the east side is a low, flat, bottom land, stretching around for miles, and has been one of the choice spots for game.

In the northeastern part of the county are two mounds, which, from the description given, must be the largest in the county, being 60 or 80 feet high and wide in proportion, but they have never been examined.


Our mounds, as a rule, do not at all compare with those on the Ohio River, about 60 miles south of us. They are small and scattered, and are generally found in groups of from 3 to 20. I must not omit to mention that there are a number of mounds outside of Wayne County, situated on the bank of a river in White County. I have never been to see them, but I have been told that they number between thirty and forty, all in a row and following the trend of the river. Throughout the county generally are found more or less of the stone implements, but they are much more plentiful near the streams and in the timbered lands, and are scarce on the prairie.

In the Smithsonian Report for 1876 (page 436) is cited a remark of Messrs. Squier and Davis relating to the disks of black flint. There have been two deposits found in this country, one in the county south of us (White), and one in the county west (Jefferson). The first one contained thirteen of them, of which I obtained eight, and the other contained forty-six, of which I obtained several. Speaking of the disks, on page 440 (1876), it is said: "Thus far not one of them has been found isolated or bearing marks of use." This is a mistake, if mine are of the same kind as those spoken of by them, as I have found three in this county, one at a time, and one of them not quite twice the size of a trade-dollar. They are of the same stone and the same shape, &c., but none bear marks of use. In addition to those given above, fifteen more mounds have been found in Massillon Township. They are on the west side of the river, about one inch (as measured on the map sent) from the north

line, on a high bluff, hardly a quarter of a mile from the river. They are somewhat in this shape, the largest mound being in the center.



The mounds in Barnhill Township, just east of Fairfield, are seven in number. They were explored two or three years ago, but nothing but charcoal was found in the bottom. I have inquired of the man living on the farm, but he

does not find many tools, &c. The mound in Big Mound Township marked  is 3 miles from here. It is, probably, a large natural mound

on the prairie, to which dirt, &c., has been brought from other parts, and so completed the cemetery. There are many graves, and several bodies or parts of bodies appear to be buried in one grave, but they are so decayed that no perfect skulls can be obtained. The graves are made by building the side and end walls of a hard sandstone, with a large one for the bottom and one for the top. The stone could not have been obtained nearer than 7 or 8 miles, on the Skillet Fork. Two trees are growing on the mound, one of them a catalpa and the other an oak, both of which have been planted, beyond a doubt. The catalpa is found in abundance in our river bottoms, but there are none on the upland. The other two mounds in the same township are also large, and located in the bottoms in the woods. One of them was found to contain human remains and a few broken pieces of pottery, but nothing of value. The other contained human remains, but not in any order of arrangements; also river shells, deer-horns, wolf jaws, &c.; also much charcoal and many small stones occur among the mass. The group of mounds in Four Mile Township is near the Skillet Fork. The one in the southwestern corner, marked "Explored," has been plowed over a great many times, and evidently contained human remains and flint tools. The second one above it was explored this spring, but not very thoroughly, as it was very warm and the woods dense. Human remains were found, and one broken piece of pottery, too small to tell its shape, and one flint arrow-point. The pottery was different from any I have ever seen, of bright-red clay and small pebbles. There are probably a great many mounds about 12 or 15 miles from here, in the woods, all of which are built on what is called Fleming's Ridge, mentioned above. Probably the Mound Builders settled on the same ground for this reason: the best ford on the river was just south of the mounds, in fact it is the only place I know of where it can be forded at all for miles. The place marked "Hay Pond" is a low place that used to be a kind of lake, which was drained by the inhabitants to catch the fish. The mound in Leech Township (on the north) is near my dwelling. Those south of it are three in number, situated as indicated in the drawing. Right on the bluff is a square hole 10 or 12 feet in diameter. All of these mounds are unexplored. The square hole used to be much deeper than it is now, about 5 to 7 feet.

MOUNDS AND EARTHWORKS IN VANDENBURG COUNTY,  
INDIANA.BY FLOYD STINSON, M. D., of *Evansville, Ind.*

On the 3d day of June, 1876, I visited Mathias Angel's farm, situated 6 miles southeast of Evansville, where I found six mounds, four distinct cemeteries, three lines of earthworks, one large stone cist, and one altar.

The first and most western mound is 15 feet high, 585 feet in circumference, truncated, and 100 feet across the top. The second mound, east-northeast of this, is 8 feet high and 150 feet in circumference. This had been dug into by Charles Artes, who found in it some human bones, burnt earth, charcoal, and ashes. Near this mound I found a stone cist, which was 8 feet long, 4 feet wide, 4 feet deep, walled with slate. In this were found several skeletons. Nearly north of this is a third mound, which is 20 feet high, 402 feet in circumference, truncated, and 60 feet across the top. On the top of this mound, just below the surface, was burnt earth. Forty yards from this I found a remarkable altar. The roof, which was sand rock, was plowed off; the sides and ends were slate, 4 inches thick; the floor the same as the roof rock. Inside it was 3 feet long, 2 feet wide, and 14 inches deep. The contents of this altar were first earth, then one-half peck of burnt and charred bones, charcoal, and ashes. Part of the bones were human, (the patella and head of the femur). Beneath this was burnt earth, and below that, earth. I have in my cabinet part of the contents of this altar.

East-southeast from the second mound is a fourth mound, which is 150 feet in circumference and 4 feet high. To the east of this is one of the most remarkable mounds I ever beheld. It is 100 yards long, 100 yards wide, and square; consequently it is 400 yards around. It is 45 feet high to a plateau, the width of which is 185 feet. Then at the southeast corner, on the top, there is an additional mound, 15 feet high, which would make a mound 60 feet high. Then at the west end there was an elevated platform 4 feet high, 150 yards long, 55 feet wide. I will designate this as the fifth mound. East and west of this great mound are burying-grounds. All of the graves in this section are walled with slate. East of this again is a sixth mound, which is 10 feet high, 30 yards in circumference. Around these six mounds is a line of earthwork, resting at either end on the river bank, and inside of this are two other short ones. The outer line is about 1 mile in length. The middle and inner lines are about  $2\frac{1}{2}$  feet high, and about every 40 yards there are mound-like widenings on the outer edges. One-half mile northeast of these mounds is a mound 50 feet high and 164 yards in circumference.

## EXPLORATION OF A MOUND NEAR BRACEVILLE, TRUMBULL COUNTY, OHIO.

BY S. N. LUTHER, of Garrettsville, Ohio.

Recently, in company with Mr. C. Baldwin, I explored an ancient mound on the estate of the late Nathan Humphrey, esq., situated one-third of a mile southeast from the center of Braceville, Trumbull County, Ohio. Miss E. B. Humphrey, who now has charge of the estate, informed me that the mound was formerly covered with a growth of heavy timber, which was cleared from it by her father many years ago, and that grading and the process of cultivation have reduced it from not less than 10 feet in altitude to its present height of  $4\frac{1}{2}$  feet. It is situated on a terrace a few feet above the alluvial bottom of the Mahoning River.

The length due east and west is 75 feet, and the breadth about 60 feet. It is elliptical in form, composed of the dark sandy loam which surrounds it, and in several places has been considerably disturbed by previous explorers and by the burrowing of woodchucks. We commenced by digging trenches from the east and south sides toward the center, somewhat below the base of the mound. In the eastern portion we found the remains of five bodies, a short distance from each other. Except the crania and fragments of the long bones, nothing could be saved, barely enough remaining to define the position in which they lay. Of the crania two were saved in fair condition. With two others we were not so successful, though enough was preserved for several measurements. The fifth was so frail that no portion of it had escaped decay. The bodies were usually buried with the head to the west, though in one case this order was reversed, the head lying to the east. Near the latter were a quantity of very bright-red ocher, pieces of pottery, and at a short distance a stone pipe of peculiar construction. Many bright fragments of stone, a few arrow-heads, and flakes of chert were found in the process of excavation. Throughout the undisturbed portion of the base, and about 1 foot from the original soil, a very hard layer of earth was discovered, 2 inches in thickness, beneath which were the skeletons. It is stated that a tier of skeletons were obtained by removing the upper part, and that many relics have been secured, but the persons who made the excavations being inaccessible, I cannot obtain authentic information of their observations.

*Measurements of the crania.*—No. 1, the best preserved skull, is that of an old person. Length, 7.05 inches; vertical height (inside measure), 4.92 inches; occipito-frontal arch, 13.09 inches; parietal diameter, 5.68 inches; horizontal circumference, 20.35 inches; cephalic index, .8056.

No. 2 is that of a young person (the wisdom teeth only partly through the process). Length, 6.90 inches; vertical height (inside measure), 5.10

inches; occipito-frontal arch, 14.45 inches; parietal diameter, 5.45 inches; horizontal circumference, 20.25 inches; cephalic index, .7898.

No. 3. Length, 7.07 inches; vertical height (inside measure), 5 inches; occipito-frontal arch, 13.30 inches; parietal diameter, 5.45 inches; horizontal circumference, 20.50 inches; cephalic index, .7708.

No. 4. Length, 7 inches; parietal diameter, 5.70 inches; cephalic index, .8143.

Three-fourths of a mile west of Hiram, Portage County, I examined a stone structure to which my attention had been called several times by persons who supposed it to be a place of burial. On viewing it, I found an annular pile of sandstone nearly 3 feet high, inclosing a space 10 feet in diameter, with an outer diameter of 25 feet, making a wall 5 feet in width. When the center was excavated, ashes and charcoal were found to the depth of 3 feet, the wall showing the action of much fire. The entire absence of bones and other kitchen refuse, with the elevated location, led to the inference that this was a signal station. It is one of the highest points on the Western Reserve, and commands a view of over 30 miles to the east, and also a portion of the Cuyahoga River on the west.

There is quite an important cemetery in the extreme southeast part of Geauga County, 2 miles southeast from the village of Parkman. The graves were mostly constructed of flat stones, placed on edge at the sides and ends. They are paved and covered with the same flagging stones found at the Grand River, which is not distant. Over these were piled loose stones. The location is a side hill, with a descent to the east. In one place the graves extended several rods up the hill in a line, in such a manner that the foot of one grave made the head of the next, and were all covered by a continuous pile of loose stone. This burial-place has been almost entirely despoiled by the persistent efforts of relic-seekers. I can learn of no implements of special interest that were found here. Those obtained consist of the commoner forms of chert, with celts, grooved axes, &c.

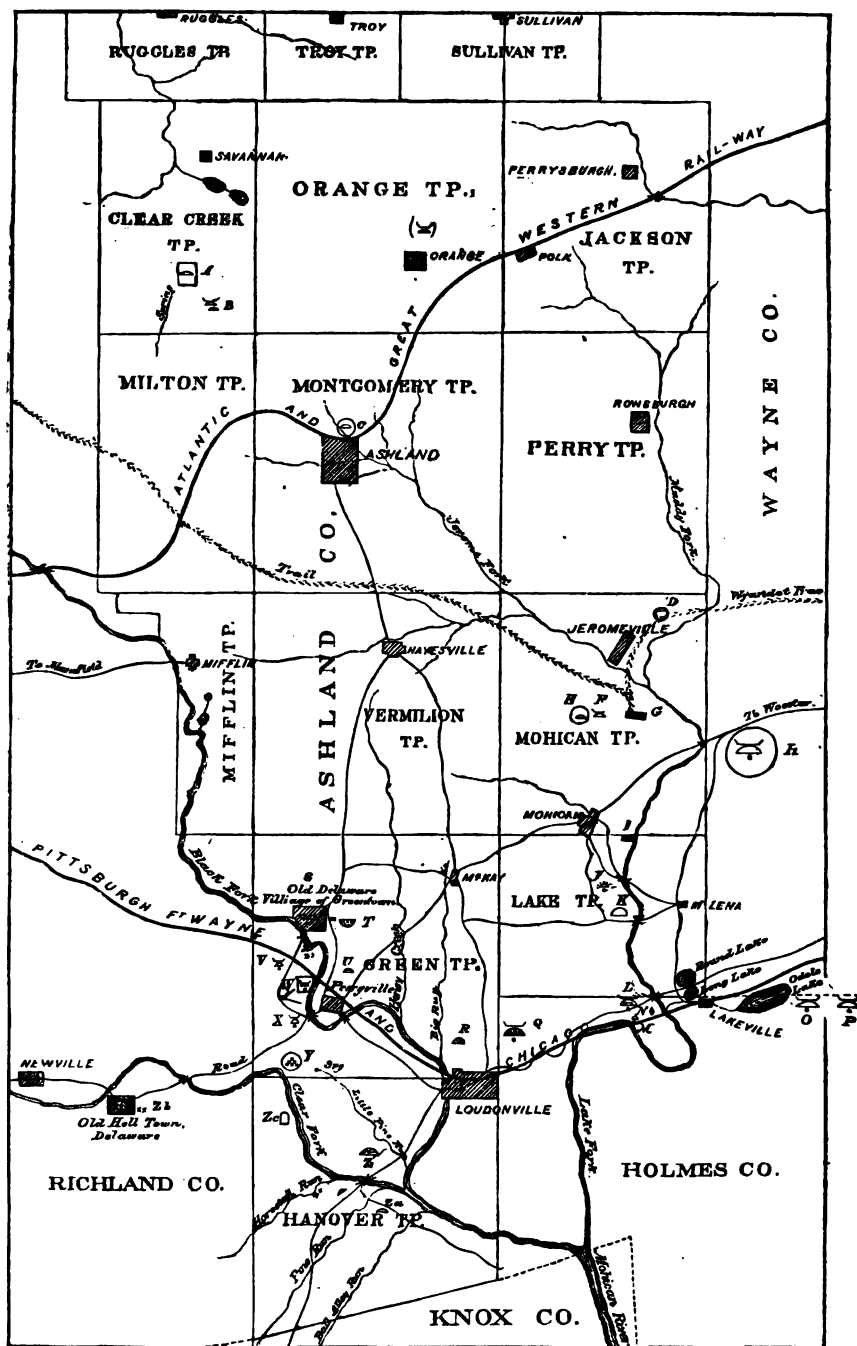
## DESCRIPTION OF MOUNDS AND EARTHWORKS IN ASHLAND COUNTY, OHIO.

BY H. B. CASE, of Loudonville, Ohio.

The accompanying map locates nearly all the mounds and earthworks in Ashland County, Ohio. Each one is indicated by a letter, and opposite the same letter in the text will be found a description of the work.

A.—This square inclosure with the gateway to the southwest is situated in section 36, Clear Creek Township, on the line between the northwest and southwest quarters of the section, upon land owned by John and Thomas Bryte. It is about 400 feet long by 200 feet wide, and has

a gateway at the southwest corner near a very strong spring. In 1824 Mr. Bryte commenced to clear his farm. The embankment at that time was from 3 to 4 feet high and 10 feet wide at the base. Both the em-



bankment and the area were covered with large oak trees. The place now goes by the name of Bryte's Fort.

B.—Two mounds stand upon a high natural elevation (90 feet) covering about 5 acres at the base, and being about 60 by 90 feet on the top, which is nearly flat. Each is 25 feet in diameter and 4 or 5 feet high. They are situated on the northeast quarter section 35, Clear Creek Township. At least one of them was explored as early as 1844, by Thomas Sprott and brother, who found a number of human skeletons in a kind of stone cist, upon which was almost a peck of red Indian paint. The bones were replaced.

C.—A circular inclosure containing 2 acres, more or less, is situated just north of the Atlantic and Great Western Railway, and within the city limits of Ashland. The farm was formerly owned by Henry Gamble. In 1812-'15 the first settlers found embankments from 3 to 4 feet high, and from 8 to 10 feet wide at the base. A forest of oak, hickory, sugar, and ash grew upon and near this work. It overlooked the valley to the south and east, and had a gateway at the southwest opening near a fine spring. The site has been plowed for more than fifty years; and scarcely a trace of it remained in 1878.

D.—At this point is a circular inclosure located near the north line of the northeast quarter section 9, Mohican Township, one mile east of Jeromeville.

E, F.—On the farm of Nicholas Glenn are a mound and an earthwork. Information might be obtained from John Glenn, jr., or from William Gondy, an old settler, both of whom live at Jeromeville, Ohio. The works are about 2 miles southwest of Jeromeville.

G.—The Mohican town called Johnstown was located here. In the years 1808-'10 it contained Delawares, Mohegans, Mohawks, Mingos, and a few Senecas and Wyandots. Captain Pipe, a Wolf Indian, ruled the village until he left it, in 1812.

H.—This large circular inclosure and burial mound are situated in Wayne County, just south of the road leading from Lake Fork to Blatchleysville, and just east of the road leading from McZena to Blatchleysville. These remains are upon a high, gradual elevation overlooking a vast range of prairie, northeast and southeast, as well as the valleys westward. The circle is a little less than one-third of a mile in circumference. At present the embankments are from 1 to 2 feet in height. The area and embankment are covered by the forest growth, which is not older than 60 or 70 years, the Indians having burned this region annually until about 1812, for the purpose of hunting. Years ago the mound was opened by unknown persons. In 1876 the author visited it, and found that an animal had burrowed into it and brought out a fragment of skull, which is now in his possession. Some time after, Mr. Thomas Bushnell, of Hayesville, made excavations in the mound and found only bones, among which was a well-preserved skull. The mound is 25 or 30 feet in diameter and 4 feet in height.



I.—A small mound, 3 or 4 feet high and 15 feet in diameter, stands upon a very high hill, perhaps the highest land in the county, and is composed of stone and clay. It was excavated some years ago by Dr. Emerick and a Mr. Long, who are said to have found a skeleton in a kneeling or sitting posture, and a pipe, both near the center. The author was unable to learn what had become of the pipe. Messrs. H. B. Care and J. Freshwater made another examination in 1876, but found nothing. There is a large spring at the foot of the hill, on the east side, but it is nearly half a mile from the spring to the mound on the hill.

J.—This work is said to be located on the west side of the creek. The author has not visited the site.

K.—In 1876 the author, in company with Mr. J. Freshwater, made a slight examination of this mound. It is 25 or 30 feet high, oval in shape, and over 100 feet long. The citizens regarded it as an artificial mound, but we considered it a natural elevation of gravel drift. Excavations might change this view. The mound is located on the west side of the Lake Fork, and just north of the road and bridge leading from Mohican to McZena in Lake Township.

L.—A mound is situated on the lands of J. L. and Cyrus Quick, in Washington Township, Holmes County, Ohio. It stands upon an eminence which slopes gradually for half a mile southward toward the bottom lands of the Lake Fork; northward and westward it declines a short distance to a small valley extending to the southwest. It is about 5 or 6 feet high, and 30 feet in diameter. Some trees were growing upon the mound when the author first visited it, some twenty-seven years ago. The trees were, perhaps, not of more than one hundred years' growth, but were as old as the trees in the immediate vicinity; not far from it, however, were oak trees 2 and 3 feet in diameter. The mound was excavated about 1820-'25 by Isaac and Thomas Quick, Daniel Priest, and others. It is said that, upon making a central excavation, they found a wooden puncheon cist, together with some human remains, and ornaments of muscle shell, which appeared to be strung around the neck. All the remains are reported to have crumbled away on being exposed to the air. It is difficult to ascertain the facts concerning this excavation. It has been said that some pottery was found also. Additional remains might be disclosed by further investigation. The persons who made the excavation are dead.

M.—This mound, located a little southwest of mound L, on the lower ground about half a mile from the same, was probably of an equal size originally, but, having been plowed for nearly fifty years, it is now spread over quite a space. It is, however, still discernible from a distance, and shows the elevation from the flat surface of the field. The yellow clay presents a contrast with the darker soil of the surrounding land. No excavation had been made until 1877, when the author, aided by Mr. Freshwater, removed about 1 square foot from the center. We

found tough, tempered clay, some bits of charcoal, but no remains. This could not be regarded as an examination, being of so small a character. Further work on this mound might unearth interesting relics.

N.—A lake is situated a short distance east of mound M, on the farm of D. Kick, Washington Township, Holmes County, Ohio. In draining this pond a *cache* of flint implements was discovered. Specimens of these implements may be seen in the Smithsonian collection. The remainder are in the author's possession. (See Smithsonian Report of 1877, article by H. B. Case.)

O, P.—There are mounds southeast of Odels' Lake, upon the summit overlooking the lake, on the farm of J. Cannon. They were excavated by Dr. Boden, of Big Prairie, Ohio, who has in his possession some teeth, jaw bones, and long bones taken from them. He says that they should be further examined. The author has not visited the mounds.

Q.—A mound stands on the summit of Dow's Hill, one mile northeast of Loudonville, just east of the Holmes County line. It was excavated about 1855 by Dr. Myers, of Fort Wayne, and D. Rust, who found a skeleton near the center, whose structure is of stone and earth. The top has since been leveled by the plow. In 1876, Mr. Lucien Rust made some excavations upon the site of the mound, and great numbers of stone were removed. At length a kind of pot or cist was unearthed, which was about 18 inches in diameter and 8 or 9 inches deep. It was formed of stone, and the edge was covered by other stones which made a roof over the pot. The removal of this roof or top showed that the cist was filled with charcoal, apparently closed while glowing coals. About 4 feet below this charcoal deposit human remains were found, reposing horizontally. Near the left hand was a perforated stone having the figure of a bird, resembling slightly the pheasant, scratched upon it. A part of a bone implement was also found. The bone, which is of firmer texture than the human bones, and is perhaps a part of the leg-bone of a deer, had been perforated, evidently with a stone drill. Lying across this lower skeleton and some distance above it were the remains of another. But little of the mound has been excavated, and further examination should be made. From the mound the view of the surrounding country is very fine. The mound proper has been obliterated for some years, but the site can be observed by a slight elevation and the great number of stones scattered about and upon it. There must have been a kind of hollow made in the Waverly shale which lies near the surface upon the underlying Waverly sandstone, of which the hill is composed, because when one digs the same depth elsewhere on the hill the shaly sandstone is penetrated. The stone implement is in the possession of L. Rust, Loudonville; the bones, bone implement, and charcoal are in the author's cabinet.

R.—This mound, similar to mound Q, is situated just north of Loudonville, on the summit of Bald Knob. For a long time it was supposed by the citizens of Loudonville to have been formed by counterfeiters in

former times. The author excavated it in 1877, and found it a veritable mound containing fragments of human bones and of charcoal. Being encased with large sandstones, and composed of stone and earth, it is very difficult to excavate. As there has been a central depression for a great many years, what remains the mound V contained of a perishable character have probably been destroyed by the collecting of water. This site also commands a fine view of the Black Fork Valley.

S.—The settlers of 1808-'09-'10 found here a village of Delawares, the remnant of a "Turtle" tribe. Their chief was a white man, taken in infancy—Capt. Silas Armstrong. They removed to Piqua, Miami County, Ohio, in 1812, the site of the old burying-ground, now almost entirely obliterated by cultivation. It is located a few rods north of the Black Fork, upon a gentle eminence, in the southwest part of northeast quarter-section 18, Green Township. The southern portion of the site is still in woods, and the depressions that mark the graves are quite distinct. Henry Harkell and the author exhumed several of the skeletons in the summer of 1876. In some cases the remains were inclosed in a stone cist; in others small, rounded drift-boulders were placed in order around the skeletons. The long bones were mostly well preserved. No perfect skull was obtained, nor were there any stone implements found in the graves. At the foot of one a clam shell was found. The graves are from  $2\frac{1}{2}$  to 3 feet deep, and the remains repose horizontally. A few relics, such as stone axes, arrow-heads, and a few bits of copper, have been picked up in the immediate vicinity. They are in the hands of the author. On the opposite side of the stream and some distance below, near the south line of southeast quarter section 18, Green Township, there are ancient fireplaces. They are about 15 inches below the present surface, and are formed of boulders regularly laid. The earth is burned red. Great numbers of stones have fallen into the streams during its incursions upon the west bank. Some three or four of these fireplaces are yet plainly visible, but in a few years they will be swept away by the current. About half a mile east of the graves marked S is a small circular earthwork almost razed. It contained about  $1\frac{1}{2}$  acres, and had a gateway looking to the river, which is westward. It is situated upon the nearly level bottom land of the beautiful valley.

T.—Upon the high ridge separating the valleys of Black Fork and Honey Creek is a depression filled with large and small boulders. J. Freshwater and the author removed them to some depth, but as the stones were heavy we desisted from further investigation. This point would command a view of the valley of the Black Fork, overlooking, as it does, the old village of Greentown; and by walking a few rods eastward on the same eminence a view of the valley of Honey Creek might be had. Most of the trees on this height are less than 100 years old. It may have been timberless during the occupation of this work. The excavation appears to have been about 15 feet in diameter.

U.—There is a stone mound, like mound R, situated on a lofty eminence overlooking the Black Fork Valley northwestward, and eastward the valley near Loudonville. The author has never seen the work, but it has been described to him as a small stone and earth mound such as are usually found on high points.

V.—A short distance northwest of mound W, on the farm of L. Oswald, southwest quarter section 18, in the woods, is a mound about 30 feet in diameter and from 4 to 6 feet high. It was slightly opened at the center by the owner of the lands, who found part of a skull.

W.—This mound and earthwork are located upon the old Parr farm, now owned by C. Byers, in the northwest part of southwest quarter section 19, Green Township. The mound stands on the west side of the Black Fork, within 2 or 3 rods of the stream. It was quite large originally, perhaps 8 or 10 feet high and 35 to 50 feet in diameter. At present it is from 4 to 6 feet above the level of the bottom land and is spread over a considerable space. When the first settlers came, there was an earthwork running a little southwest from the mound for some 20 rods, then back eastward to the river. The place has been under cultivation for forty or fifty years and the work is now obliterated. The mound was encased with a wall of sandstone boulders as large as a man can lift.

These stones must have been carried from the hill half a mile west, where they are found in place. The wall was carefully laid, as can be seen by excavations below the depth of the plow where the pile is still intact. The mound was examined in 1816 by some persons named Slater, who found in it bones, flint implements, a pipe, and a copper wedge which they thought gold. Accordingly they took it to a silversmith at Wooster, Ohio, who told them that it was copper, and bought it from them for a trifle. In 1878 the mound was explored by J. Freshwater and the author. The center of the mound, where not disturbed by former excavations, resembles an altar or fire-place where the fire had burned the earth to a brick-red. In the ashes and burnt earth were fragments of arrow-heads broken by the heat. The fire had been kindled on the mound when it was from  $2\frac{1}{2}$  to 3 feet high. No human remains were discovered in this last excavation. A few scrapers were found, which are in the cabinets of the above-named gentlemen.

X.—On the summit of a hill west of Perryville, and to the right of the road leading to Newville, was a mound, now entirely obliterated. In 1816-'20 it was opened by the Slaters, who found a pipe, human remains, and some other relics.

Y.—A large oval earthwork on the summit of the ridge between the valleys of Black Fork and Clear Fork. It is 210 feet wide by 350 feet long. About the center of the inclosure was a large pile of stone boulders, most of which have been removed to the level of the ground. There is, however, a visible outline of the stone-work, which consisted of a paved circular space. No excavation has been made in either the stone or clay

work beyond 1 or 2 feet in depth; consequently the character of the mound is unknown. A forest, containing oak trees over 30 inches in diameter and other large trees, covers most of the work, but a portion extends into a field and has been almost razed by the plow.

*Z.*—On a high hill directly north of the junction of the Black Fork and the Clear Fork, and overlooking the same, is a stone and earth mound composed principally of large sandstones from the immediate vicinity. Some twenty or twenty-five years ago it was explored by unknown persons. The author examined it again in 1877, but discovered nothing. A similar mound is said to have been located upon the hill south of the Clear Fork, just below the junction of Pine Run. The stone were hauled away and the site plowed over. (See *Za.*)

*Zb.*—This is the site of Old Delaware village of Hell Town. It was deserted about 1782, the time of the massacre of Anaden Hutten. Graves were visible until two years ago; the field is now cleared and plowed. In the author's cabinet are two iron scalping-knives and an iron tomahawk which were thrown up by the plow; also the brass mountings of a gun, a gun-flint, a stone ax, and some arrow-heads. Dr. James Henderson, of Newville, Ohio, has in his possession several articles obtained from this site. The Indians formerly called their settlement Clear Town, and the stream Clear Fork; but learning the German word *hell*, for clear or bright, they changed the name to Hell Town.

*Zc.*—A rock shelter is located on the west side of Clear Fork, in the conglomerate sandstone of the Lower Carboniferous. It was explored in 1877 by L. Rust and the author, who found about 2 feet of ashes intermingled with a few animal bones and coprolites. No human remains were disclosed excepting a split bone, and even that is doubtful. The ashes continue deeper, and further examination might prove interesting.

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## EARTH-WORKS NEAR JONES' STATION, IN BUTLER COUNTY, OHIO.

BY J. P. MACLEAN, of *Hamilton, Ohio.*

While I was engaged in examining the earth-works of Butler County, Ohio, I was informed by Mr. John W. Erwin that an ancient work was near Jones' Station. On repairing thither I was unable to find either the work or any one who had ever heard of it. I next attempted to find the papers of Mr. James McBride, but no one knew what had become of them. The record of the sale of McBride's effects gave no account of them.

During the month of December, 1879, I received a note from Mr. W. S. Vaux, of Philadelphia, stating that he owned both the cabinet and the archæological papers of the late James McBride. I immediately applied for that portion of the papers relating to the earth-works near

Jones' Station. These papers were placed in my possession January 26, 1880. On the 27th of the month, in company with Mr. John W. Erwin, I started to locate the works. Although it had been nearly thirty-eight years since Mr. Erwin visited the spot and assisted in the survey, and made the original delineation, he recognized the spot and the plan of the works as preserved in the papers of James McBride.

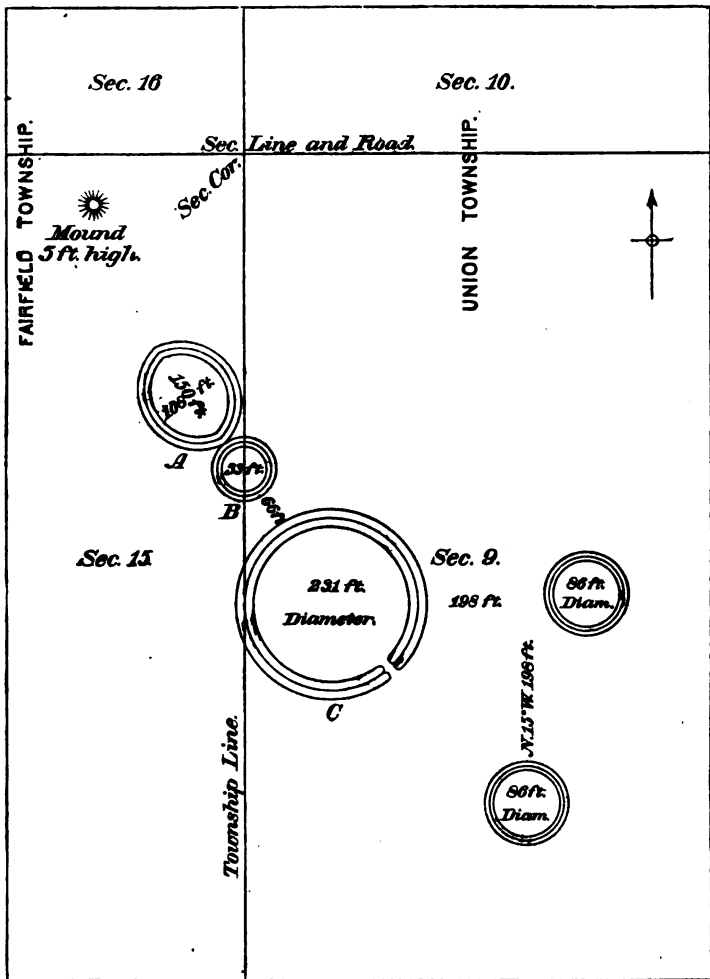
These works were located on the southeastern slope of one of the highest hills in the vicinity. The hill is a detached one and surrounded entirely by one of the richest valleys in the State. Between it and the uplands toward the north was originally a swamp. This swamp was drained at the expense of and under the direction of the State. Through it passes the Miami Canal. The hill is composed of a yellowish clay, having been formed during that period known as the glacial or drift. Its summit is about 225 feet higher than the city of Hamilton.

The works are now entirely obliterated. There is not the slightest evidence that they ever existed. We searched in vain. They occurred in both Fairfield and Union Townships, on section 15 of the former and 9 of the latter. The township line passing through the works, if extended southward, would terminate at the foot of Broadway, in Cincinnati. The work marked A is wholly in Fairfield Township, while the township line passes through the center of the smallest circle, marked B. The same line passes on a fraction of the wall of the largest circle, C. On the summit of the hill, Fairfield Township, section 15, is a mound composed of yellow clay, about 5 feet high, from the top of which a commanding view of the surrounding country may be obtained. It probably belongs to that class of mounds known as signal stations. It would be impossible to tell the original height of this tumulus. The plow for fifty-two successive years has accomplished all this destruction.

James McBride came to this county in the year 1808; and, as he early took an interest in antiquities, it is probable he saw these works before the forest trees had been cut away. He and John W. Erwin surveyed the works May 7, 1842. The following is a verbatim copy of Mr. McBride's description:

*"Saturday May 7, 1842.*—Went, in company with John W. Erwin, civil engineer, and James McBride, jr., to an ancient work in Butler County, Ohio, six miles southeast from the town of Hamilton, on the lands of James Beaty. The work is situated principally on section No. 9, town 3, range 2, M. R., about 30 poles south of the N. W. corner of the section. On measuring the main part of the work it was found to be a true circle 3 ch. 5 links in diameter. The ground was cleared some 14 or 15 years ago, and has been cultivated since that time, consequently the height of the embankment has been much reduced. Previous to cultivation the embankment was fully three feet high above the natural surface of the ground. Inside of the embankment was a ditch two feet deep, making a perpendicular height of about 5 feet from the bottom of the ditch to the top of the bank.

"Three chains east of this work is another circular work 1 ch. 30 links in diameter, and from this in a direction S. 15° W. three chains distant is another circular work of the same dimensions, viz, 1 ch. 30 links diameter, and also the same distance, viz, 3 ch. 00 links from the center or main work.



"At the distance of one chain N. W. from the center or main work is another small circular work two poles in diameter, and adjoining and touching this is still another enclosure, of an oval form, from 2 ch. 30 links by 1 ch. 70 links in diameter, extending in a N. W. direction.

"The embankment of the smaller works before reduced by cultivation was upwards of two feet high above the natural surface, with ditches on the inside eighteen inches deep.

"On the S. E. of the main work is an opening in the embankment com-

municating with the smaller works to the S. E. Probably communications might have existed throughout from one work to the other, though they cannot now be distinctly traced.

"The embankments of these works are of a bright yellow clay, different from that which appears on the surface of the surrounding ground, hence the form of the works can be distinctly seen and traced as far as the eye can see them."

## MOUNDS IN BOYLE AND MERCER COUNTIES, KENTUCKY.

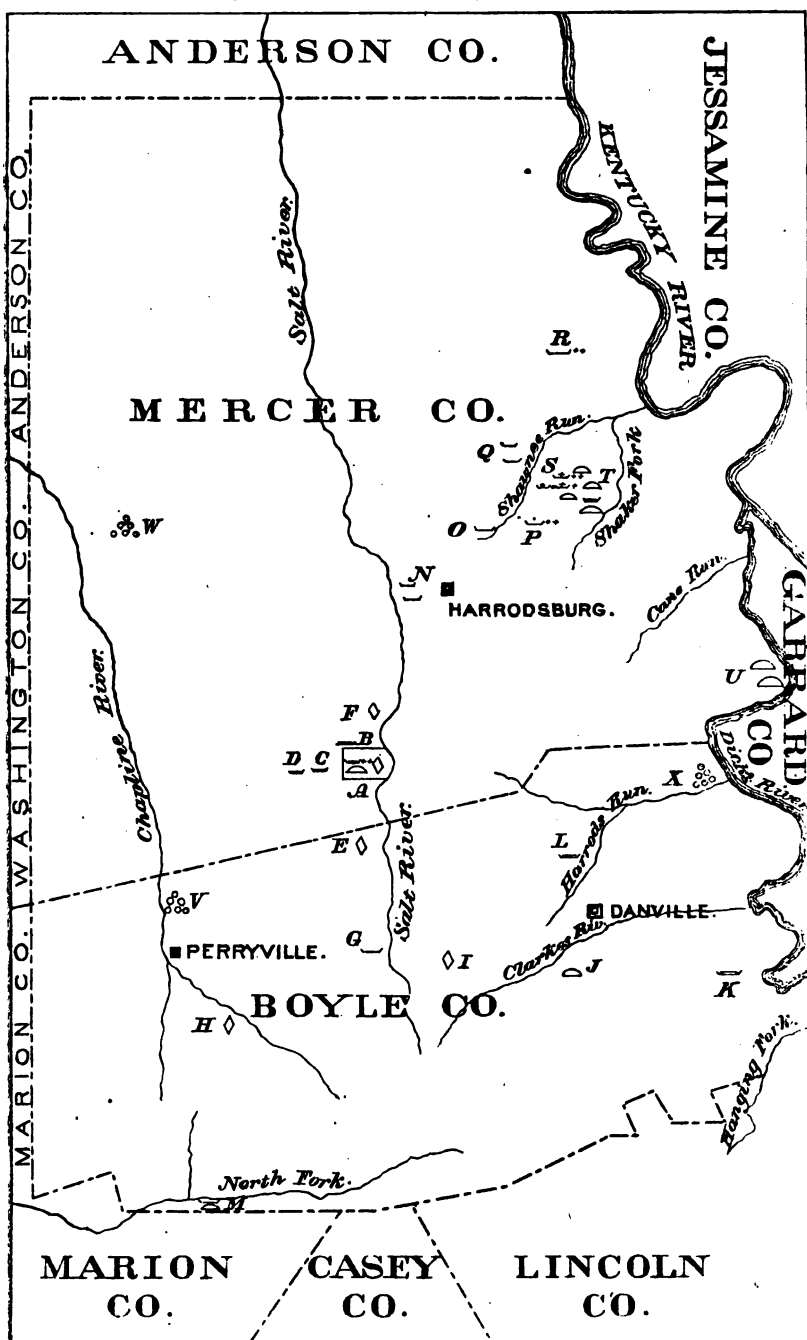
By W. M. LINNEY, of Harrodsburg, Ky.

In the counties of Boyle and Mercer, State of Kentucky, there are a number of mounds, graves, &c., which were constructed by former inhabitants of the country, and many aboriginal implements have been found. On the map of Boyle and Mercer Counties I have located all points of interest that I have been able to learn. They will be alluded to more particularly in the following notes by the letters that are connected with them. The point of greatest interest (A on the map) is situated on the west bank of Salt River, in Mercer County, a little north of its union with Boyle County, on a farm owned by Dr. Thomas Hyle. The first notice given of this point is found in "Collins' History of Kentucky," under the head of Mercer County. Speaking of ancient towns and fortifications, it says: "There are two of these, both on Salt River, about 4 miles above Harrodsburg, containing ditches and a mound 10 or 12 feet high, filled with human bones and broken pieces of crockery-ware. On one side of the mound a hickory tree, about 2 feet in diameter, grew and was blown up by the roots, making a hole 3 or 4 feet deep. Its lower root drew up a large piece of crockery-ware which had been on some fire coals. The handle was attached to it, and human hair lay on the coals. This was probably a place of human sacrifice. The other ruins were about a mile and a half above this, both being on the west bank of Salt River. There is no mound near this, but only the remains dug out of ditches."

The ground has been cleared, and the continual cultivation of the land has filled up the ditches and removed all traces of any lines that once existed. The mound has also been removed by the plow. From it have been taken, as cultivation yearly went on, the bones of a number of human skeletons, none of which were retained, few of them being in a good state of preservation; the skulls crushed to fragments and the soft ends of the bones, with few exceptions, gone entirely. I do not know that any relics have been taken from the mound proper, except some shell beads. The river bank here is only about 15 feet high, and the slope back from the river is not more than 2°. The mound stood 200 yards from the stream. Between those points there must have been a village of huts or some form of habitation; for even now, when the



ground is freshly plowed, there is a regular parallelogram, where the uniform lines of black earth, charcoal, and burnt bones show the former presence of fires long continued at that point. Within this area have



been found a great number of specimens of broken crockery, plain and ornamented in crossed lines; grooved axes of greenstone; celts in greenstone, jasper, agate, hornstone, and limestone; pipes, arrow and lance heads, chisels, grinding stones, pestles, sinkers, flint flakes and cores, ornaments in slates and other colored stones; bones of fish and many animals, horns of deer and elk, teeth of bears, &c. Some of these may have been thrown up by the plow and scattered over the space near the mound. From the number of fragments of various stones, it seems that there was a workshop here, and so I have located one on the map. The mound was built of earth taken from the vicinity, and there were evidently some large stones in connection with it, but how they were placed is not known. B, C, D were within a mile of A, and were single graves. They have all been opened, and each contained one skeleton, without implements or ornaments so far as known. In one, the body seemed to have been buried horizontally, on the right side, with the head to the east; the position of the others is unknown. There seemed to have been a stone cist erected on or near the surface of the ground; and then rocks appear to have been set on edge around it, until a space 10 or 12 feet square was inclosed. If ever covered with earth, time has removed it down to the rocks. B is on the farm of Dr. Thomas Hyle, and C and D on that of Cornelius Terhune. E and F are points on Salt River, above and below A, where remains of pottery, &c., have been found; but their real character cannot be determined. E is on the farm of John Ludwich, in Boyle County, and F on that of Mrs. Lewis.

G is a grave on the farm of Thomas Knox, but I have not seen it. From description it is like B, C, and D.

H is only a point marked by great numbers of flint chippings and broken arrow-heads.

I represents a space on a farm owned by W. B. Cecil, where a great many pipes, axes, &c., have been found.

J is a mound of earth on the farm of the Misses Craig, about  $1\frac{1}{2}$  miles south of Danville, in Boyle County. It is some 5 feet high and 50 feet in circumference. It has been opened, but I know of nothing obtained from it.

K is located on the farm of John F. Yedger. It has been opened, and is similar to B, C, D.

L is in Boyle County, on the land of Wyatt Hughes. It was destroyed by excavating a road-bed for a railroad; and seems to have been like B, C, and D.

M is a small earthen mound on the southern bank of Rolling Fork, Boyle County. It has been razed by cultivation. Some bones, a grooved ax, and a few arrow-heads of hornstone were disclosed.

N is said to be the site of two graves, and is just west of Harrodsburg and "old Williams" place. From what I can learn the graves are like B, C, D.

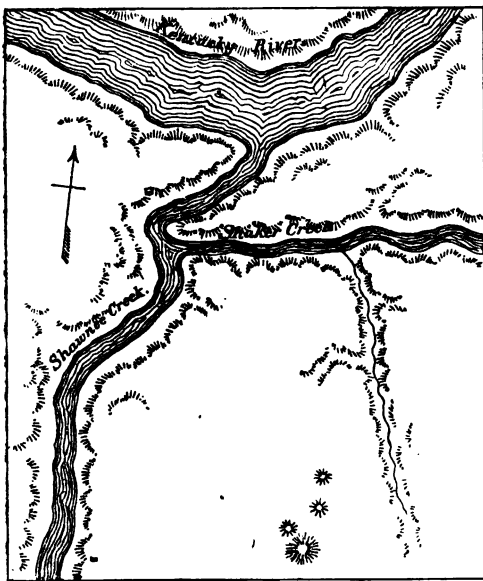
O is a single (?) grave with stones set up around it. I have not examined it, but from appearances it is like B, C, D.

P is an earthen mound, on the farm of J. A. Shuttleworth. It is 4 feet high and 50 feet in circumference, and was opened in 1807 or 1811 and later. From an old man, who was a boy when it was first opened, I learn that a number of bodies had been buried in it, and that an ax or two were found. On the night of the day on which it was opened occurred the earthquake of that year, and the whole neighborhood thought that the Indians had come after them for disturbing their bones.

Q was one or two graves, now obliterated, on the farm of Achilles Davis.

R is a point on the farm of Dr. Walter Davis, where some relics were found in digging the foundation of a house. A lot of bones were near these relics.

S is the site of three graves covered with stones placed on edge, and is on the farm of George Davis, sr. The two near each other have been opened, and a number of human remains were exhumed from each. They had, seemingly, been buried with their heads together and their feet radiating from this center. Plates of mica were found with the crushed skulls, as if they had been placed over their eyes. Only one implement was obtained here. A bone had apparently been buried with one of the



bodies, and, when discovered, it was lying upon the arm, at the elbow, and parallel to it. The third grave has not yet been examined, but will probably be explored in the spring.

T is a group of four earthen mounds on the farm of Thomas Coleman. They have all been excavated at some time. The last examination took place in July past, and yielded one skeleton, and a copper bead almost destroyed by oxidization. Their relative positions as to streams and to each other is shown in diagram T. (See also the accompanying plan.)

U is the site of two mounds 8 feet high, and 60 or 70 feet in circumference, on land owned by Mr. Hugely, upon the bluffs of Dick's River. The mounds seem to be composed of gravel, earth, and limestone. Several persons have examined them, and pronounced them mounds. Partial excavations have been made, but without success. Poplar trees (*Liriodendron*) 2 feet in diameter are growing upon them. I am disposed to think that the mounds are the remains of lime-kilns made in the first settlement of the State; at any rate the limestone in them has been burned.

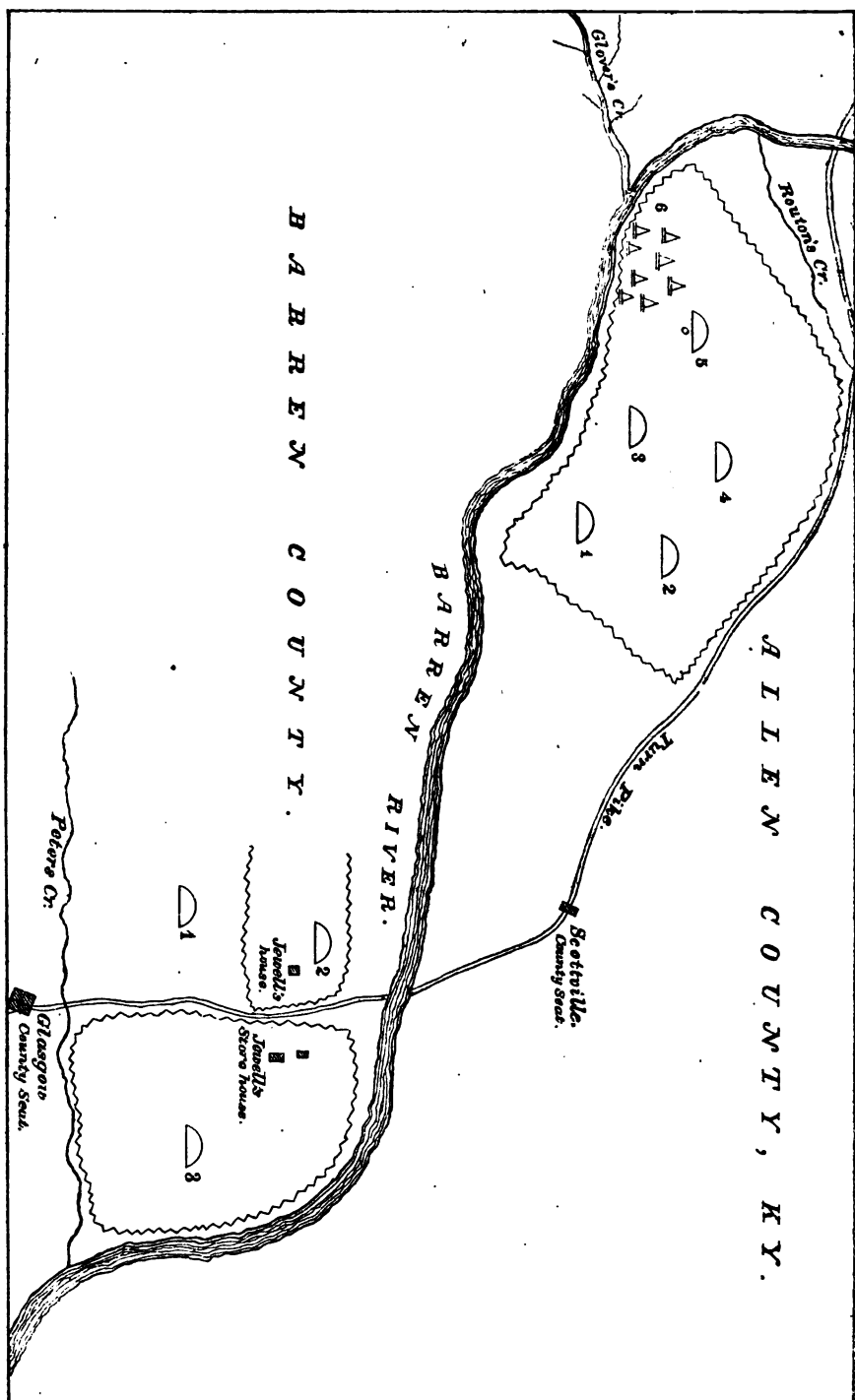
V was a large pile of rocks, giving no evidence of ever having been covered with earth. It was opened and some skeletons were found, probably those of Indians killed in some attack on Harrodsburg.

W and X are similar to V.

The above list includes all the points of much interest in these two counties. Nearly every spot mentioned has been examined, and the relics carried off or destroyed. The great majority of those relics, such as pipes, arrow and lance heads, grooved axes, and celts, have been plowed up isolated in fields all over the counties; but the larger number have been found on the farms contiguous to Salt River. No shell heaps have been noticed except at A, where the common mussel of Salt River seems to have been used for some purpose other than pottery manufacture, perhaps as food.

Nothing is known as to our caves or cliff shelters having been used for dwellings. A cave east of Danville, on the farm of Samuel Stone, contained some human skeletons; but as the remains had been thrown down into a sink-hole without other opening, and as there were no implements, I suppose that the persons were Indians, or perhaps murdered whites of a comparatively recent date, and not mound-builders. The bones were in a good state of preservation. Nowhere in this part of the State has anything resembling masonry been observed, to my knowledge.

As far as I can learn, no carving, engraving, or sculpture has been discovered in those counties; but in the Deaf and Dumb Institution at Danville, Professor Dudley, principal, there is a carved image or rather bust of Aztec type, which was plowed up in Marion County, Kentucky. Rock paintings and inscriptions are not found here. The dead are discovered both in mounds and in isolated graves. Some contain one individual, others more. It is difficult to determine the position of the bodies when interred, as the pressure from above and the trees over them have forced them out of place. Some appear to have been buried in a sitting posture, some were stretched out, and others evidently lying on their sides. They were laid, in most cases, toward the east, sometimes toward the west, and again in every direction like spokes in a wheel. A few were placed in cists, others in earth only. Generally only a few of the more solid bones were preserved. At one point in Boyle County some arrow-heads were turned up by the plow, but they were lost or thrown away. No large places are known where flint implements have been manufactured; but chippings, evidently broken off by mechanical means, show that arrow-heads have been made in limited quantities. I am unable to learn whether or not the pottery found at A had been made on the grounds. The presence of many fragments, the quantities of decaying mussel shells, the balls of sand carried from the river, and the proximity to suitable clay all render it likely; yet there are no places, that I could see, which give any reliable evidence of its manufacture.



PLAN 1.

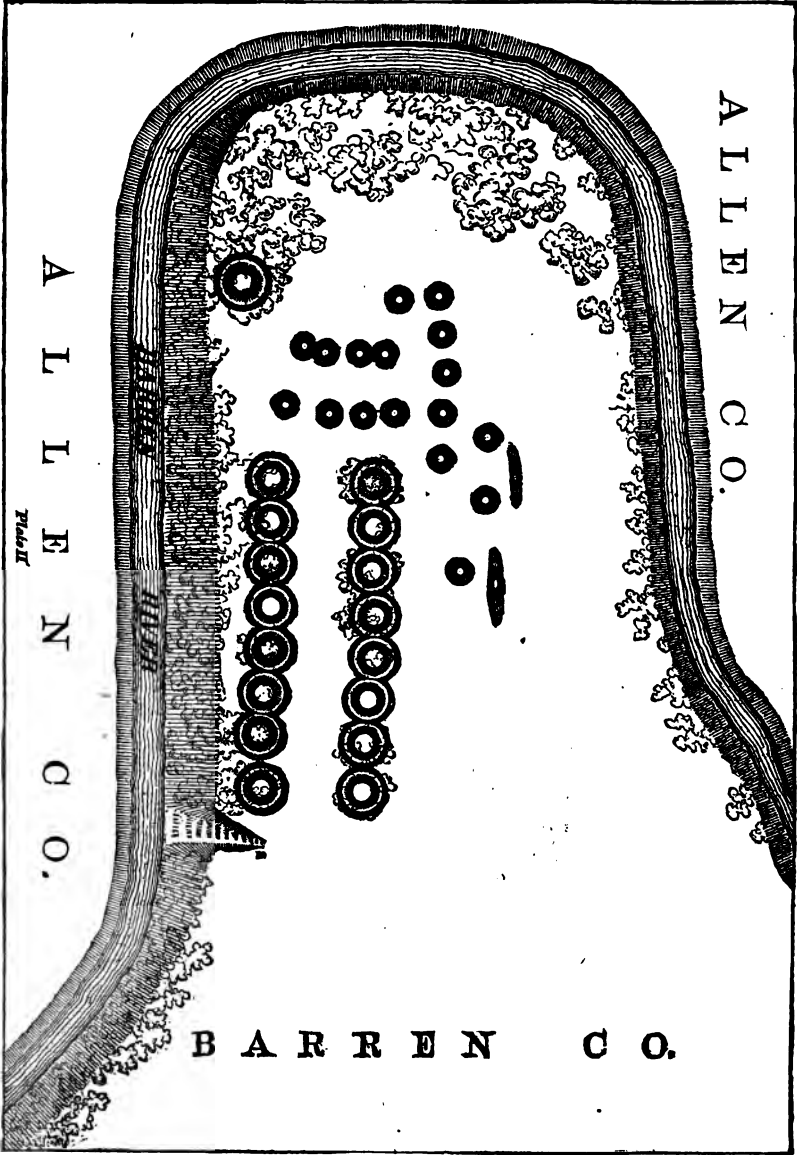
## MOUNDS IN BARREN AND ALLEN COUNTIES, KENTUCKY.

BY R. B. EVANS.

I. *Mounds in Allen County.*—The figures in the text refer to the accompanying map. Nos. 1, 2, 3, 4, and 5 are mounds on Barren River, and near the mouth of Rounton's Creek. They are inclosed in one corner of a cultivated field, though covered thickly with large trees. No. 5 was explored about fifty years ago, and some stone implements and a silver pipe were found. The author does not know what became of them. About two years ago he thoroughly examined No. 1, and discovered many large bones, which, however, were much decayed. The vault was 10 feet deep from the top of the mound, and 8 feet in diameter. It was round, and walled up with stones like a well. Every 2 feet was a layer of large flat rocks, and between these layers were human remains. The bottom was made of stones laid edgewise, and, being keyed in with small stones, was consequently very tight. Old farmers in the neighborhood say that Nos. 1, 2, 3, and 4 have never been excavated. No. 6 is a cluster of graves which were formed of stones placed edgewise. Some of the graves are long and others short, the longest being 8 feet and the shortest  $2\frac{1}{2}$  feet in extent. The author opened one and found some human bones in a very decayed state.

II. *Mounds in Barren County.*—Nos. 1, 2, and 3 are mounds on Barren River, at the mouth of Peter's Creek. From No. 3, the largest, a great many human bones and several stone implements have been taken. The author has one specimen of the latter. Nos. 1 and 2 are not so large, and have never been explored. They have been seen by Professor Putnam, of Cambridge. The mounds are bare of timber. No. 3 is now used as a graveyard by J. F. Jewell, the owner of the land.

III. *Ancient town and cemetery in Barren County, Kentucky.*—The accompanying diagram, Plan II, represents the location and details of an aboriginal town and burying-ground on the Barren River, in Barren County, Kentucky. The work occupies a bluff 60 feet high. The sixteen circular figures are lodge sites, partly raised on the outer rim and depressed in the center. In the center of each, a foot beneath the surface, were found coals, the grain of the wood being easily distinguished as oak and poplar. The diameters of these rings average about 18 feet. The other figures represent mounds. These works are now in the virgin forest. One of the mounds was opened by the author, but a detailed account of the exploration will have to be deferred.



## MOUNDS ON FLYNN'S CREEK, JACKSON COUNTY, TENNESSEE.

BY JOSHUA HAITE, Sr., of Jackson County, Tenn.

The valley in which these mounds are situated is on the east bank of Flynn's Creek, which empties into the Cumberland River, and is 3 miles above the mouth of the creek and 1 mile south of the river. The valley is 4 miles west of Gainesboro', the county seat, and near the center of a section of country that abounds in mounds and graves. This valley which is full of these graves, contains near 100 acres, and is the site of the village called Flynn's Lick. There are five limestone springs, one sulphur spring, and a salt spring. From the number of mounds of earth, stone, and shell, it is evident that it has been a large town and a place of note among the inhabitants of that day. A further reason is that the valley is easily approached from every direction. The valley is full of graves, placed as close as they can be in the ground. It has been in cultivation sixty-five years. Before it was cleared it was covered with a dense forest of trees, some of which are from 4 to 6 feet in diameter. Even on the tops of these mounds trees were standing (of the oak and poplar species) measuring 4 and 5 feet in diameter. At the time the valley was cleared it was not known that there were any graves there.

The graves are of all sizes, varying from 18 inches to 6 feet in length and the usual size in width. The coffins are made of slate-rock slabs (which now seems to be plentiful 4 miles up the creek, where there is a large quarry), and are generally neatly polished. The bones and pottery are now found from 18 to 20 inches below the surface of the ground. The coffins are constructed in the following manner: They first placed on the bottom of the grave one or two slabs of slate-work neatly polished and jointed closely together in the middle when they had to use two of them; they next placed one at the head and one at the foot of the grave; then they set up one or two, as the case required, on edge on both sides, neatly fitted together in the middle and at the ends, which forms a box. They next took one or two pieces, as the size of the coffin demanded, neatly polished and jointed together in the middle and at the ends, and placed them on for the lid, projecting on all sides from 2 to 4 inches. Occasionally we find a grave where they have used limestone instead of slate rock.

On the east side of the creek, about 100 yards from its bank, is the grand earthen mound, which is larger and higher than any of the others in the valley. All the graves as a general rule face this grand mound; but occasionally, owing to the rock in the ground, this rule is varied and the direction changed, showing that closeness or compactness was their leading idea.

The mounds referred to in this valley and vicinity are composed both of earth and stone, and are found on both sides of the creek. The



largest earthen mound, which I call the grand mound because all the graves are facing it, is about ninety feet in diameter, and at this time about 4 feet high; but when first discovered by whites it was 5 or 6 feet high. This mound has not yet been examined, but others in the valley, not so high but larger in diameter, have been looked into and were found to contain graves, pottery-ware, pipes and arrow-heads made of dirt or cut out of rock. These are found in the graves in the mound and in those around it.

On a hill adjacent to the valley, about 200 feet high, are six stone mounds constructed of rough limestone rock. These mounds are situated about 300 yards east of the valley. They are about 20 feet in diameter and  $2\frac{1}{2}$  or 3 feet high. Four of them have been examined, and all of them were found to be full of human bones and pottery ware, but not so close together as the others. The graves were constructed, or covered over with rock, differently from the others. The corpse seems to have been put in first, and then rock slabs set up and placed together at the top in the shape of the roof of a house. In this way was the place filled with graves all over a certain spot, and then rough stone piled on until the mound was formed. I have spoken of only six mounds on this hill, of this kind; but there are many in this vicinity of this kind, but they have not been examined. Near the center of the mound examined by me, in a grave, were found bones of a human being charred perfectly black, around which were placed all the others.

On the west side of the creek is a bluff in which were found several holes, and on examination one of them was found to lead into a cave which has been explored for about 100 yards. This cave contains several apartments which are dry, and within this are found a great many human bones, some of which are still in a state of preservation.

A female skeleton was taken from a grave found about 80 yards west of the mound that I have designated in this letter as the grand mound. This skeleton was lying with the face towards the mound, with a pipe in her right hand resting on her right thigh. With this skeleton I found in opening the grave an infant child lying with its feet against the thigh bones of its mother. When first opened this child's skull-bone and other bones were in perfect form, but as soon as the air came in contact with it it broke into lime, or powder. This female evidently died in childbirth, the feet of the foetus coming first. This female we are led to believe, from the pains taken in burying her, must have been of note amongst them, for I found in disinterring this skeleton that the remains were deposited in a wooden coffin, and then this one was put into one of neatly polished rock. A jug was found, with the mouth down and the bottom upwards, placed against the skull-bone. The stone with a hole in the center, which is called a corn-muller, I found about 80 yards from the grand mound. This was plowed up and found, among a large number of human bones in a decayed condition, upon the top of a small mound in the valley. The pottery, of the character sent, is found in all the graves and in a similar condition.

## ANTIQUITIES AND ABORIGINES OF TEXAS.

BY A. R. ROMSSLER, of *Washington, D. C.*

In my frequent walks, some years since, along the beaches of the bays and inlets of the Gulf of Mexico, a few miles south of the Guadalupe River, I rarely failed to find a number of aboriginal relics—especially immediately after the ebb of a high tide. I have also found many about the bases of the sandy hillocks, or “dunes,” which have been heaped up by the winds in many places along the coast. I have occasionally found large flints; but these were probably used for harpoons. Some of these arrow-heads are very rudely wrought, while others, particularly a very small kind, are of exquisite finish, with a point as sharp as a lancet, and the cutting edges finely and beautifully serrated. Most of the specimens collected by me had necks, or shanks, by which they were fitted into the shaft; a few, however, were without this appendage, but were either grooved or beveled on both sides of the base of the tongue. The flint pebbles, from which these arrow-heads were chipped, were probably obtained from 30 to 40 miles inland, where they abound in several localities. All the Indian tribes of Texas, when it was first colonized by Americans, used metallic arrow-heads, which they had probably substituted for flint ones nearly a century before, or not long after the establishment of the missions and military posts of San Antonio and La Bahia, where they doubtless obtained copper, brass, and iron, all of which metals they used for pointing their missiles. Fragments of earthen pottery are coextensive with the flint relics. But they bear evidence that our aborigines were never much skilled in the ceramic art.

The Indian dead usually receive very shallow sepulture. Often the Texas tribes do not bury their dead at all, but merely pile logs or stones upon their bodies, which are soon extricated and the flesh devoured by beasts of prey. The bones being thus left to the action of the elements, rapidly decay. Hence the osseous remains of the aborigines are rarely found far inland, but in various places along the coast the winds have performed the rites of sepulture by blowing the sand upon the dead. At Igleside, in 1861, human bones were disinterred at two localities more than a hundred yards apart, from a depth of 8 feet; and recently, in October, 1877, others were discovered in a sand hill, or “dune,” near what is locally known as the “False Live Oak,” in Refugio County. About a month after the discovery I went to the spot and found that a large quantity of human bones, including several skulls, had been exposed by the caving of the “dune;” but being much decayed, had broken to pieces in falling, and quickly dissolved in the Gulf tide at the base of the “dune.” I saw for 40 feet along the face of the steep slope, from which the sand had slidden, a number of human bones and skulls projecting at various angles. One skull, which was better preserved

than the rest, was of medium size and remarkably round. The others seemed of similar size and type. The teeth of all were well preserved, and did not exhibit any appearance of having been faulty during the lifetime of their owners. None of the bones seemed to have belonged to persons above the average size, with the exception of one femur. Neither the vertebral nor pelvic bones, the ribs, the omoplates, nor the bones of the hands and feet were preserved. These human remains were from 5 to 7½ feet beneath the surface of the ground, and 10 or 12 feet above the level of the bay.

After an interval of about six weeks, I again visited the spot. About 2 feet of the hill had caved away since my first visit; but the bone deposit was still unexhausted, for I found three more skulls and several limb bones, all of which broke into fragments in extracting them from the compact sand.

I was disappointed in not finding stone arrow-heads in the caved sand. But my search for them was not thorough. There is no reason, however, to doubt that these are aboriginal remains. Their imperfect state of preservation in any kind of earth, very conservative of organic substances, alone warrants the conclusion that they are ancient, which is reinforced by an argument which I will here state. These remains are found at the southern extremity of a sand ridge about 2 miles long from north to south, and varying in height from 20 to 40 or 50 feet, and which was evidently formed while the gulf beat directly upon the shore of the mainland. But ever since the long, sandy islands extending parallel with our coast were heaped up by the action of the waves and currents of the sea, the only communication between the gulf and the interior bays, or lagoons, has been through a few narrow channels called "bayous." The consequence is, that the sandy materials of which the "dunes" are formed, instead of reaching the shore of the mainland as in former ages, are now deposited on the gulf side of the islands and blown up by the east and southeast winds into hillocks similar to, but generally less elevated than, those which were formerly heaped by the same agency upon the mainland.

Now, on the assumption that these human remains, in accordance with the universal custom of North American savages, were only interred to the depth of 2 feet at most, several feet of sand must subsequently have been blown over them to account for the depth at which they were found, and the sand for this purpose must have been transported to the adjacent beach by the currents of the gulf. Hence, I conclude that the remains were deposited in the "dune" before the gulf was cut off from the mainland by the formation of the chain of island barriers above mentioned. The sand ridge containing the osseous relics has been preserved from the wasting effects of the winds by the thickets of dwarf oak and sweet bay with which it is overgrown. Some of the live oaks at its eastern base are of sufficient girth to indicate an age of two centuries. Other oaks of the same species a short distance south

of the "dunes," and very near the bay, are of much greater antiquity. All these trees must have grown up since the Gulf retreated behind Matagorda Island, which at this point is about 8 miles distant from the mainland. From all of which it follows as highly probable that the human remains, which I have described, were inhumed at a period when the broad waves of the sea resounded along the shore of the mainland, and before the sail of a ship had gleamed on the Gulf of Mexico.

Both history and tradition preserve the names of several tribes of Texas Indians, which had become extinct or had been blended with other tribes before the State was first colonized by Anglo-Americans, at which period, A. D. 1821, the only tribes with which the settlers came in contact were the Comanches, Wacos, Tawacanies, Ionies, Keechies, Lipans, Tonkaways, and Carancaways. Of all these tribes the last named was the most remarkable. They inhabited the coast, and ranged from Galveston Island to the Rio Grande. The men were of tall stature, generally 6 feet high, and the bow of every warrior was as long as his body. These Indians navigated the bays and inlets in canoes, and subsisted, to a considerable extent, on fish. They were believed by many of the early settlers to be cannibals; but it is probable that the only cannibalism to which they were addicted was that which was occasionally practised by the Tonkaways, if not by all the tribes of Texas. This consisted in eating bits of an enemy's flesh at their war dances to inspire them with courage. A dance and feast of this kind I once witnessed at a settlement on the Colorado, where the Tonkaways were temporarily camped. A party of its braves on a war tramp slew a Comanche, and upon their return to their tribe brought with them a portion of the dried flesh of their slain foeman. This human "tasajo," after being boiled, was partaken of by the warriors of the tribe with cries and gestures of exultation. Their thievish and murderous propensities early involved them in war with the settlers of Austin Colony, by whom they were repeatedly defeated with severe loss, in consequence of which, about the year 1825, they fled west of San Antonio River, whither they were pursued by Austin at the head of a strong party of his colonists. When he arrived at the Manahuila Creek, 6 miles east of Galliad—then called La Bahia—he was met by a Catholic priest of that place, who bore a proposition from the Carancaways, that if Austin would desist from hostilities they would never in future range east of the San Antonio.

Austin agreed to this proposition and countermarched his force. The Carancaways, however, did not long keep their promise. A few years afterwards several parties of them returned to the Colorado, their favorite resort, and committed divers thefts and atrocious murders, for which they were again severely scourged by the colonists.

Efforts were long made by the Catholic missionaries to christianize these savages, and the mission of Refugio, 30 miles south of Galliad, was, I believe, founded for that special purpose. But the Carancaways

were proof against all civilizing influences. At length, about the year 1843, forty or fifty men, women, and children—the sole remnant of this tribe, which twenty-one years before numbered nearly a thousand souls—emigrated to Mexico, and were permitted to settle in the interior of the State of Tamaulipas. At this time it is not improbable that the Carancaways are almost, if not quite, extinct. I am unable to ascertain whether any of the other tribes mentioned before in this paper are also verging on extinction, but it is well known that they have all rapidly diminished in numbers since they came in contact with civilization, and the conclusion is inevitable that in a score or two of years all the smaller tribes will become as extinct as the mammoth and the mastodon that preceded them.

### MOUNDS, WORKSHOPS, AND STONE-HEAPS IN JEFFERSON COUNTY, ALABAMA.

BY WILLIAM GESNER, *of Birmingham, Alabama.*

Three mounds are to be seen in township 17, range 1 west, of Jefferson County, about 4 miles north of Birmingham, and west of the South and North Alabama Railroad, in that portion of Jones Valley through which flows Village Creek from east to west. They are on the north side of the creek where it is forded, on the Birmingham and Huntsville wagon road, and west of the machinery and buildings of the Birmingham Water Works Company about 1 mile. The largest of them is nearest to, and visible from, this road toward the west. The one, which is the most southerly of the group, appears to be about 30 feet high, conical, and about 100 feet in diameter at its base; the others, distant from it and from each other, about 300 yards, are not in a direct line with each other. The second one north has not one-third the dimension of the first, and the third is much smaller than the second. They are situated on the plain of one of the most fertile tracts of land in Jones Valley, which has been cultivated for more than fifty years.

Five Mile Creek, also flowing from east to west, through the hills, from out of this Jones anticlinal Valley, along the base of low ridges of Millstone Grit, bordering the Warrior Coal Field on the southeast, being crossed at Boyles Gap, on the South and North Alabama Railroad, places these mounds between two streams, abounding in fish, and tributary to the Black Warrior River. Their immediate locality is unsurpassed by any other region of the State for number, size, clearness, and coolness of the springs, issuing from out both the ridges of Silurian quartzites, and beds of limestone outcropping in the valley. They have been injured to some extent by hunters and farming operations, particularly the smallest one, but the largest one has oaks and other trees of large dimensions on it, growing without thriving. No explorations having been made of any of them, their arrangement and composition remain unknown.

*Workshops.*—In township 18, range 7 east, of Talladega County, on the headwaters of Talladega Creek, at the eastern end of Cedar Ridge, (a spur of the Rebecca Potsdam sandstone Mountain) in the old fields where the Montgomery Mining & Manufacturing Company's, Sulphur, Bluestone, Copperas, and Alum Works were situated, wagon loads of quartz fragments, broken arrow-heads, and spear-points, cover the ground; but on a much larger scale appears to have been the manufactory of these implements in township 19, range 27 east, of Lee County, on the Columbus Georgia branch of the Western Railroad east of Yonkesborough; for in the fields, on the southeastern side of a low ridge called Storees Mountain, many acres are covered with the broken quartz, in every variety of that mineral found in this hill, from transparent rock crystal to jasper and chalcedony; among which occasional good implements occur.

*Stone-heaps.*—In township 23, range 14 east, of Chilton County, on the middle prong of Yellowleaf Creek, about  $3\frac{1}{2}$  miles northeast of Jemison Station, on the South and North Alabama Railroad, there are three stone heaps. The first one is about 100 yards from and on the west bank, being about 20 feet in diameter, and from 4 to 5 feet high at the center, with a post oak and pine growing on it of ancient appearance, and each of them about 8 inches in stump measurement. Two others nearly west of this, distant about 700 yards on the eastern brow of the ridge, are about 100 yards apart; one of them about 10 and the other 20 feet in diameter at the base and from 4 to 5 feet high at the center, which, though in the primitive forest, have no trees growing on them. Another, 1 mile east of these, on a more westerly ridge, in the same range and township, is about 50 feet in diameter at the base and over 5 feet high at the center. In township 21, range 3 west, on the quartzite ridge east of Siluria (about 1 mile), on the South and North Alabama Railroad, occurs a smaller stone heap than any of those before mentioned, supposed to be the grave of an Indian warrior.

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## ABORIGINAL SOAPSTONE QUARRY AND SHELL-HEAPS IN ALABAMA.

BY CHARLES MOHR, of Mobile, Alabama.

In the course of a mineralogical trip through the region of metamorphic rocks in this state, stopping at Dudleyville, Tallapoosa County, I heard much of an ancient soapstone quarry, worked by a race of which, according to the statements of the first settlers amongst the Creeks and Muscogeas, no tradition existed among these tribes. I was urgently pressed, but could not go, to visit the quarry myself, so it is due to Dr. Johnston, of Dudleyville, that I am enabled to make this contribution. The gentleman writes: "I picked up the large fragments near excava-

tions in the rock from the very place where the ancient stonecutter left his rude and unfinished work." Allusion to these so-called soapstone excavations and pottery is made in the second biennial report on the Geology of Alabama, by Professor Toumey, 1858, and also in the first report of the Progress of Geological Survey of Alabama, by Dr. E. Smith, 1874, pages, 86, 94, and 118. The rock from which this specimen has been quarried is rather a fibrous serpentine, intermixed partly with an asbestoid actinite than a soapstone. A stone chisel has, according to the statement of Dr. Johnston, been found in the soapstone quarries, and was undoubtedly an instrument used in cutting and dressing the vessels, and is of a porphyritic or dioritic rock foreign to the geological formation in that section.

I found a peculiar tablet of indurated ferruginous clay, the straight lines along the margin of which would lead one to think that it was used for a tally, worn around the neck suspended by a string. It was found in an old field on the western shore of Mobile Bay, near Magnolia race course. In this county two kinds of shell-banks or shell-mounds are met with.

The first are situated in the low marshes of the delta of Mobile River, first recognized as artificial accumulations of shells, and described as the *gnathodon* beds by Professor Toumey in his second biennial report on Geology of Alabama, 1858. He mentions the same at the time of his visit extending over several acres of ground, and some with an elevation of from 10 to 20 feet, presenting the shape of truncated cones, covered with a growth of native forest trees. These beds are almost entirely made of the shells of *Gnathodon cuneatus*, but in some quantities of stone of *Ocyrena carolinensis* and the *Neritina reclinata* have served in a less degree to swell those accumulations; together with these, charcoal, ashes, and the bones of birds and animals are found. Relics of the handicraft of the builders of these shell-mounds are almost unknown. Professor Toumey speaks of an instrument cut from the shell of the *Pyrula ficus* which he found 10 feet below the surface, and of scarce fragments of pottery. These beds are, at this day, almost all levelled to the ground, and are rapidly disappearing, many having been appropriated as excellent sites for market gardens, and vast quantities of shells have been, and are still, removed for the construction of our shell-roads. The time is rapidly approaching when scarce any vestige will be left of them, and it is therefore most to be wished that the little of what yet remains should be closely investigated, and a minute account be put upon permanent record.

The other shell-banks are situated on the eastern and western shores of Mobile Bay, and along the coast of the Mississippi sound to the mouth of the Pascagoula. They are all above tide-water on dry land, contiguous to the extensive oyster beds in these waters, and composed exclusively of the oyster. The most interesting and the most extensive of these accumulations made by the ancient *Ostreaphagi* is found on the

north side of the Bayou Cock d'Indes near its mouth, a few miles distant from Bayou La Batterie, in the extreme southern part of this county. But comparatively a small part of the large mound is left, and what remains serves as a beautiful site for a farm house, shaded by magnificent live oaks of the growth perhaps of scores of decades, offering under their shade, from an elevation of from 25 to 35 feet, a fine view of the surrounding country, and the island-studded waters of the Gulf. A quarter of a century ago these banks furnished this city for years with lime for building, and are still much used for the construction of roadbeds; having, however, passed of late years into the hands of farmers, the application of lime for agricultural purposes tends now, more than anything else, to their demolition and rapid disappearance. Considerable quantities of remains of the industries of these shell-bank builders have been found, mostly in the shape of ornamental pottery, as testified by a collection of these relics in the hands of Major Walthall. They consist of a pipe, bowls, handles of pots, mouthpieces of jars, representing heads of birds and animals, and human heads with a most characteristic and impressive cast of features, reminding me strongly of the faces of Mexican idols. Some of these are almost indetical with those mentioned by Mr. Putman, in his report on the Peabody Museum of Archaeology and Ethnology, published in the June number of the *American Naturalist*, and figured under Nos. 7775-76, specimens representing female heads bearing the very same features and the same style of head-dress as No. 7778. They are all made of soft clay found on the bay shore, mixed with very small particles of burnt shell. What interested me mostly in looking over these remains is the occurrence of the same double concave, rounded, and polished disks, agreeing exactly with those of No. 7838 in the same paper.

I learn that near Mount Vernon Arsenal, 30 miles distant from this city, and about  $3\frac{1}{2}$  miles from the Alabama River, are ancient burial grounds, and that the exploration of the same has, from time to time, been attempted by different persons, I do not know with what result.

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### SILVER CROSSES FROM AN INDIAN GRAVE-MOUND AT COOSAWATTEE OLD TOWN, MURRAY COUNTY, GEORGIA.

BY CHARLES C. JONES, JR., LL.D., *Augusta, Ga.*

The two silver crosses, correct representations\* of which are herewith presented, were taken, in November, 1832, from a grave-mound at Coosawattee Old Town, in Murray County, Georgia. Indian relics were found associated with them. We incline to the opinion that they may properly be referred to the expedition of Hernando de Soto.

If we interpret aright the wanderings of the Adelantado over the

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\*These drawings are half-size, and delineate both faces of each cross.



territory embraced within the geographical limits of the modern State of Georgia, his command halted for a while at the precise spot where these objects were obtained; and thence, moving down the valley of the Oostanaula, reached Chiaha, the site of the present town of Rome, where De Soto tarried during the month of June, 1540, to recruit his men and animals.

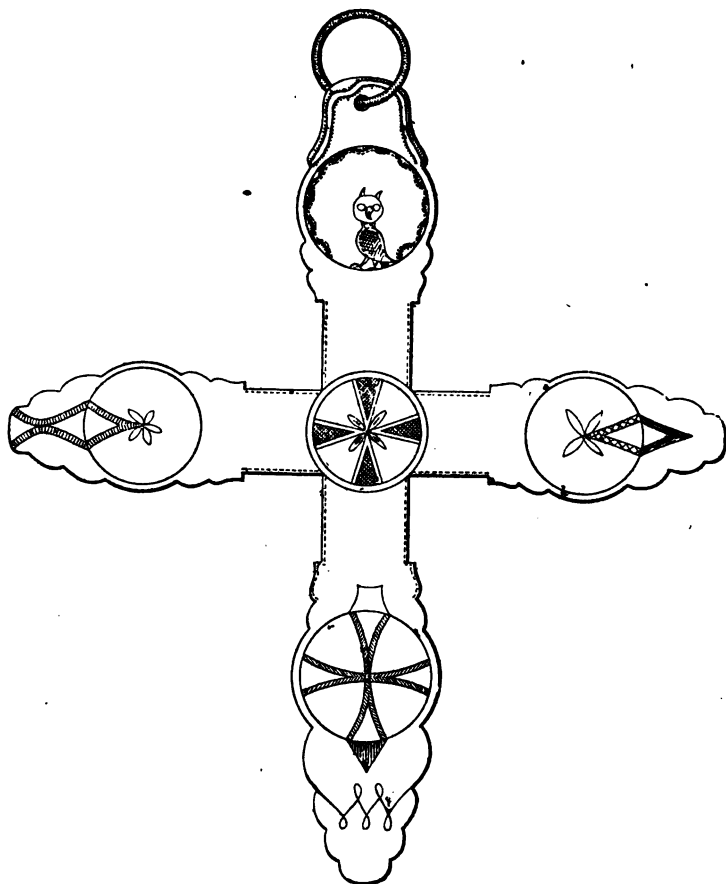


FIG. A.1.

In the Spanish narrative we are informed that before entering the village of Canasagua the strangers were met by twenty natives, each bearing a basket of mulberries.

Now, this name *Canasagua* lives to-day, and is borne by the *Connasagua River*, which, uniting with the Coosawattee, forms the Oostanaula. Coosawattee Old Town is located not far above the confluence of these streams. Within the historic period it continued to be a favorite abode of the Cherokee Indians.

In the neighboring county of Habersham, metallic objects of Euro-

pean manufacture have been unearthed under such circumstances that we feel justified in attributing them to the companions either of De Soto or of Louis de Velasco.

It is a well-established fact that twelve priests, eight clergymen of inferior rank, and four monks accompanied the Adelantado's army. We are assured that the conversion of the natives was one of the avowed

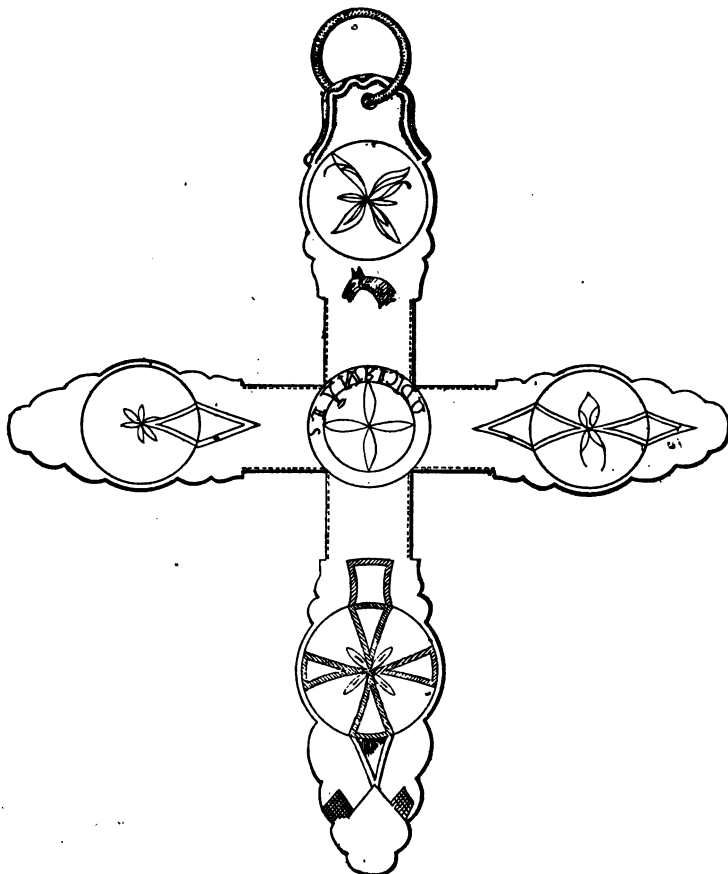


FIG. A 2.

purposes of the expedition. These clerical gentlemen were supplied with crucifixes, crosses, and rosaries, which they employed about, and distributed during the course of, their religious labors. That some effort was made to indoctrinate the aborigines in the mysteries of Christianity, and to lead them to look upon the cross as a symbol of peace, we are distinctly advised. Witness the erection of large wooden crosses, and the teachings of the priests at Achese, at Casqui, in the province of Icasqui, and elsewhere.

It appears by no means improbable that these crosses were presented

by the Spanish clergymen of the expedition to prominent Indians—reckoned as converts at the time—and that their fellows, in obedience to a custom long established and maintained even to the present moment, upon the death of the fortunate owners, buried them in the grave-mounds erected for their sepulture.

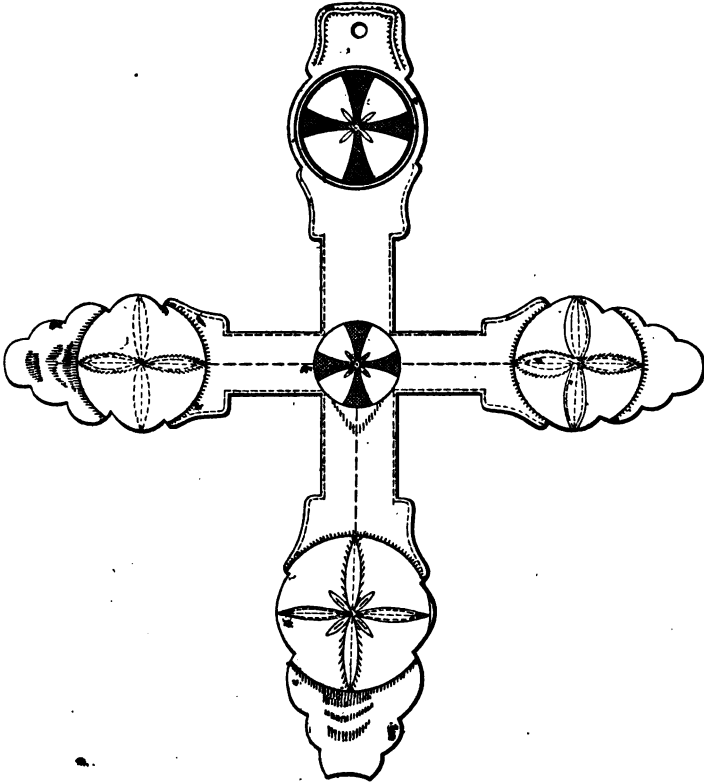


FIG. B 1.

We regret that we have no suitable references at hand which would enable us to determine, at least approximatively, the date of the manufacture of these crosses. The silver of which they are made is seemingly quite pure, and each cross is about the thirtieth of an inch in thickness.

Some intrusive engraving appears on the face of one of these objects. Behold the delineation of the head and neck of a *horse*! Even the most superficial examination will convince any one that this figure was not made with the graver's tool which wrought the other ornamentations, but that it was more rudely done, and, in all likelihood, with the sharp point of a flint flake.

Why an *owl* should have been figured on the other face of this cross, I know not. Were this a Roman relic our wonder would not be excited.

We are at a loss to suggest a satisfactory interpretation of the inscription appearing in the center of one of the faces of the cross which still retains its ring for suspension. Can it be a rude tracing by the donor, on the spur of the moment, of the name of the Indian to whom the cross was presented? This inscription has an illiterate, unskillful, and hasty look about it. It is not of a kind with the rest of the engraving, and was certainly added after the completion of the object. Writ-

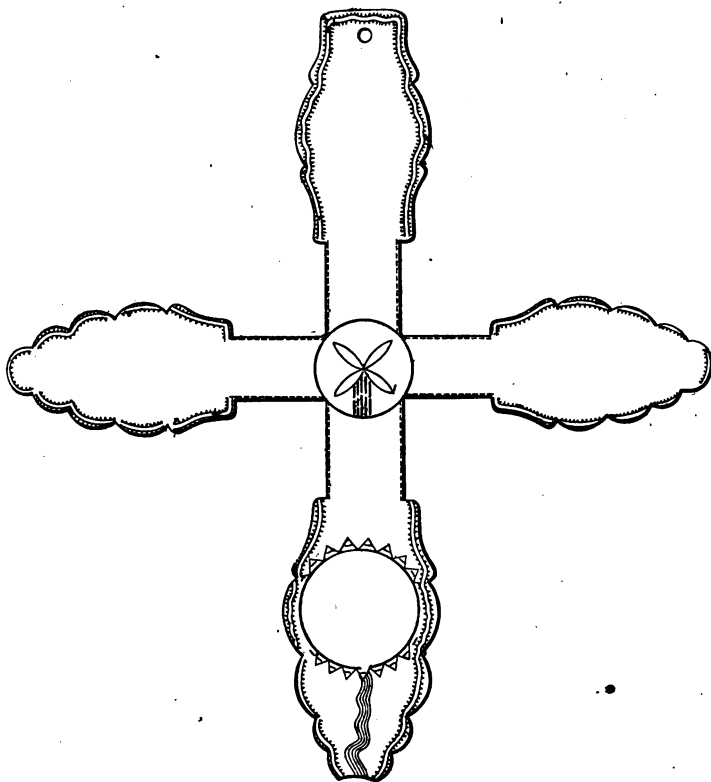


FIG. B 2.

ten from left to right, it runs as follows: IYNKICIDU. Read from right to left, we have UDICIKNYI. In either case, by a slight exercise of the imagination, we have a name with a traditional aboriginal ring about it. Manifestly these letters were not within the double circle when the cross passed from the shop of the silversmith, and we are persuaded that both a clumsy tool and an unskilled hand were employed in their superscription.

As we well know, the Florida tribes were wholly unacquainted with the *horse* prior to the advent of the European. To them, therefore, on its first appearance, this quadruped must have proved an object of special interest and wonder. These silver ornaments, too, were doubt-

less held in high esteem, because, in beauty of material, symmetry of form, and excellency of manufacture, they far excelled all the products of aboriginal fabrication.

May we not suggest that the native, into whose ownership one of these crosses passed, endeavored with a flint flake to perpetuate his recollection of this animal which, in his esteem, was not less remarkable than the pale-faced stranger or his shining gift? We cannot resist the impression that this equinal delineation was the work of an Indian.

## THE GREAT MOUND ON THE ETOWAH RIVER, GEORGIA.

BY CHARLES WHITTLESEY, of *Cleveland, Ohio.*

Not having seen a detailed description of this mound, I made a visit to it in behalf of the Western Reserve Historical Society in May, 1871. It stands upon the north bank of the Etowah, about 2 miles below where it is crossed by the Chattanooga and Atlanta Railway, near Cartersville. Its form, size, and elevation are singular and imposing. It occupies the easterly point or angle of a large and luxuriant river bottom, a part of which is subject to inundations. The soil is a deep, rich, black loam, covering several hundred acres, which has been cultivated in corn and cotton since the Cherokees left it about forty years since.

I was compelled, by bad weather, to make the survey in haste. The bearings were taken with a prismatic compass, the distances measured

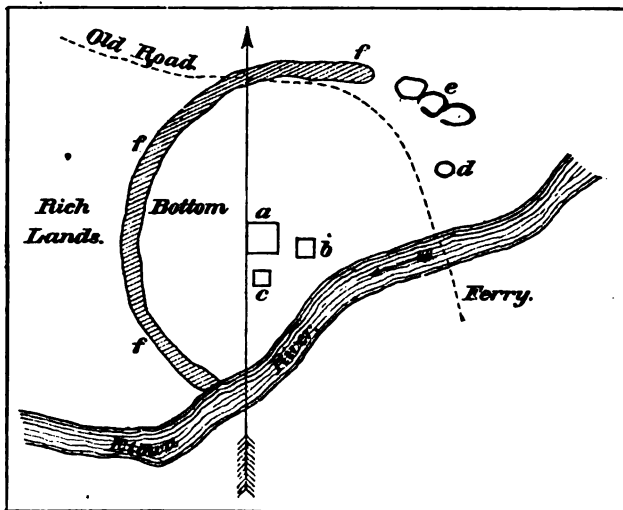


FIG. 1.

by pacing, and the elevations obtained with a pocket level. They are therefore subject to the corrections of future surveyors. Its base covers a space of about 3 acres, and stands at a level of 23 feet above low water in the river. In great floods the water approaches near the mound on

the west, but has not been known to reach it. The body of the mound has an irregular figure, as shown in the plan. It is longest on the meridian, its diameter in that direction being about 270 feet. On the top is a nearly level area of about an acre, the average height of which is 50 feet above the base. A broad ramp or graded way (1) winds upward from the plain, around the south face of the mound, to the area on the top.

Like some of the pyramids of Egypt, it has two smaller ones as tenders: one on the south, *C*; another to the southeast, *B*; each about 100 feet distant, their bases nearly square, and of nearly equal dimensions. If they were not in the shadow of the great mound they would attract attention for their size and regularity. The ground at *B* is 3 feet higher than at *C*. All of them are truncated. The mound *C* is not a perfectly regular figure, but approaches a square, with one side broken into three lines. Its height above base is 18 feet. The bearing of its western side is north  $10^{\circ}$  west, and the length on the ground 47 paces, having been somewhat spread out by plowing around the foot. On the east is a

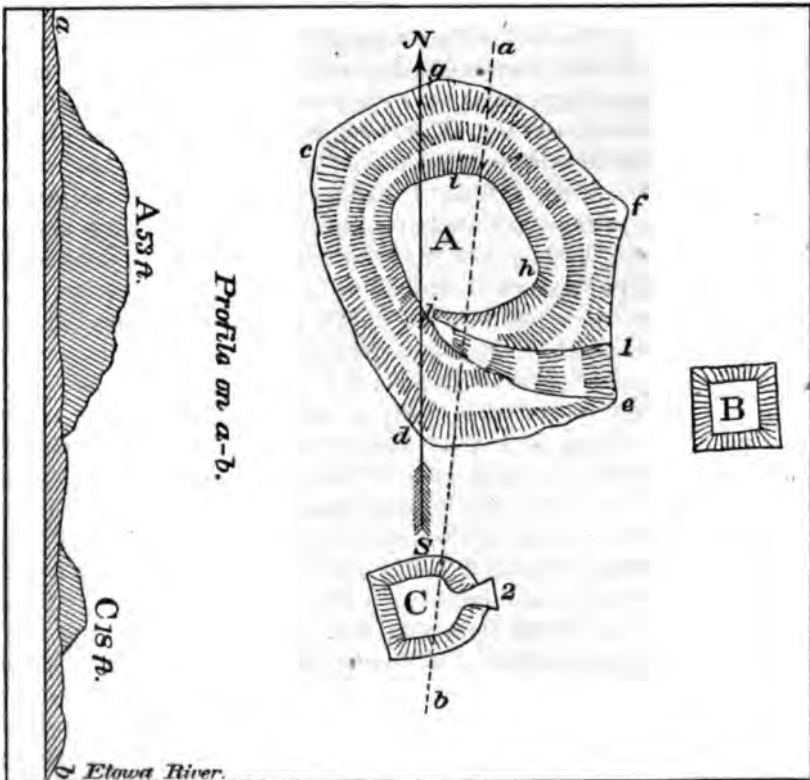


FIG. 2.

ramp, with a slope of one to two degrees which allows of ready ascent by persons on foot.

The slopes of all the mounds are very steep and quite perfect, in  
S. Mis. 109—40

some places still standing at an angle of  $45^{\circ}$ . *B* is a regular truncated pyramid, with a square base about 106 feet on a side, two of the faces bearing  $5^{\circ}$  west of the meridian. Its elevation is 22 feet. There is no ramp, or place of ascent which is less steep than the general slopes.

Towards the southeast corner of the surface of *B* is a sunken place as though a vault had fallen in.

The proprietor has managed to cultivate the summits of all the mounds, regarding the group in the light of a continual injury by the loss of several acres of ground. Most of the material of the mounds is the rich black mold of the bottom land, with occasional lumps of red clay. The soil on their sides and summits produces corn, cotton, grass, vines, and bushes in full luxuriance. The perimeter of the base of the great mound is 534 paces. As the ground had been recently plowed and was soaked with a deluge of rain, a pace will represent little more than 2 feet. I give the circumference provisionally at 370 yards. The area on the top is like the base, oblong north and south, but its figure is more regular. Its perimeter is 231 paces.

From the center of the pyramid *O* a line on the magnetic meridian passes a few feet to the west of the center of the platform on the summit of *A*. Its sides are nowhere washed or gullied by rains. Prior to the clearing of the land, large trees flourished on the top and on the slopes. I estimate its mass to contain 117,000 cubic yards, which is about four-fifths of the Prussian earth monument on the field of Waterloo.

At the base the ramp is 50 feet broad, growing narrower as you ascend. It curves to the right, and reaches the area on the top near its southwest corner. Twenty-five years since, before it was injured by cultivation, visitors could easily ride to the summit on horseback along the ramp. From this spot the view of the rich valley of the Etowah, towards the west, and of the picturesque hills which border it on either side, is one of surpassing beauty.

About 300 yards to the north rises the second terrace of the valley, composed of red clay and gravel. Near the foot of it are the remains of a ditch, inclosing this group of mounds in an arc of a circle, at a distance of about 200 yards. The western end rests on the river below the mounds, into which the high waters back up a considerable distance.

It has been principally filled up by cultivation. The owner of the premises says there was originally an embankment along the edge of the ditch on the side of the pyramids, but other old settlers say there was none. If the last statement is correct, a part of the earth composing the mounds can be accounted for by the ditch.

Its length is about one-fourth of a mile, and it does not extend to the river above the mounds. Near the upper end are two oblong irregular pits, 12 to 15 feet deep, from which a part of the earth of the mounds may have been taken. The diameter of the pits varies from 150 to 200 feet, and the breadth from 60 to 70. The ditch is reputed to have been 30 feet wide and 10 feet deep. Two hundred yards to the northeast of

*A* are the remains of four low mounds within the ditch, near the large pits. Five hundred yards to the northwest, on the edge of the second terrace, is a mound which is yet 8 feet high, although it has been industriously plowed over more than thirty years. On the opposite side of the river, one-fourth of a mile below, and on the same side 2 miles below, are said to be small mounds.

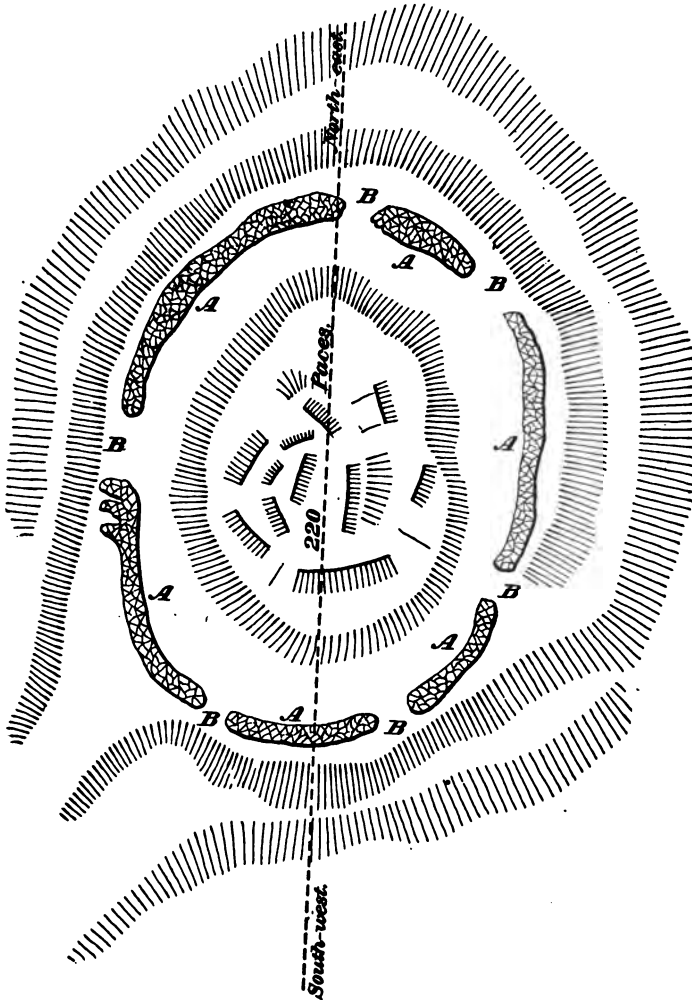


FIG. 3.

On the summit of a rocky hill,  $2\frac{1}{2}$  miles northwest, which overlooks the valley of the Etowah towards Rome, and also the hill country on the south, is an inclosure of loose unhewn stones, known as the "Indian Fort." It has now the appearance of a heavy stone fence which has fallen down. There are six openings or entrances, *B B B*, having a breadth of 10 to 60 feet, situated at irregular distances. It is an irregu-



lar oval figure inclosing the rocky summit of the hill, the largest diameter of which is 220 paces and the shorter 200. The elevation of the knob, at the center, is 50 feet above the terrace or bench, on which the lines of loose stones are lying. This interior space is principally cleared of loose stone, and shows bare ledges of lime rock, in horizontal layers.

The hill is covered with an open growth of oaks. There is nothing in this structure suggestive of a fort, except its elevated position, which, however, is by no means inaccessible. The openings are too wide and too numerous to warrant the idea of a defensive work. It is more probable that it was the scene of imposing public processions and displays, and was approached by crowds of persons from all sides through the openings. The rude wall or line of stones would be the necessary result of clearing the ground of the blocks of limestone once scattered profusely over the surface.

Near where the railway from Cartersville to Cedarville crosses Petit's Creek, at the base of the limestone bluff, about half a mile east of the "fort," is an artificial pile of small stones, which was once about 18 feet in height. It is now very much injured by persons in search of treasure and of relics, who have formed a crater at the center nearly down to the ground, throwing the stones over the sides. It must have been a regular cone, with smaller heaps attached around its base, which was irregular, and about 160 feet in circumference. This mound of stones does not differ from those raised by the red men over the remains of their dead chiefs except in size.

A few days before I was at the great mound, a rude stone effigy of a female was plowed out near its base on the north side. It is quite grotesque, resembling the uncouth carvings in wood of the Indians of the north. Its height is 14 inches, its weight 36 pounds, and the material is the limestone of the region.



FIG. 4.



FIG. 5.

I have a photograph of it, viewed on three sides. On the hips and back are colored zigzag lines of white and brown, intended for ornament. Some years since a male, probably the mate to it, was plowed out near the same place; also an earthen vase and other pottery, with flint disks. The first-found image was lost or destroyed, and the other soon will be. In style and artistic execution they appear to be the work of the present red man.

Mr. Tumlin, the owner of the premises, and Mr. Sage, of Cartersville, who knew the country while the Cherokees were in possession of it, state that the summit of the great pyramid was a fortified village, surrounded by pickets of wood and a slight embankment. This parapet is still visible, but is, at least in part, owing to



FIG. 6.

furrows turned outward in plowing, and, until recently, the stumps of the pickets were struck by the plow. Near the southeast corner of the area, on the top, is a low mound. It is a third of a mile, at the nearest point, to where there is land of a height equal to the mound, and therefore it was a place easily defended. Although the Cherokees made use of it as a fort against the Creeks, they always denied having any knowledge of the race or the persons by whom the mound was erected. The gentlemen above named questioned them repeatedly on this point, and always received the same answer. If it had been designed as a place of defense originally, a much less broad and gentle road to the summit would have been made.

I was attracted to this mound and its surroundings as a type of the flat-top pyramids, so common on the waters of the Gulf of Mexico, which have been by some archaeologists attributed to the present race of red men. In Florida and in Alabama, the early English and Spanish travelers found Indian caciques with their wigwams on the top of such mounds, around which were the villages of their tribe. Instances are given where Indian towns occupied spaces surrounded by ancient embankments of earth, both with and without mounds.

Mr. S. F. Haven, long distinguished in archaeology as the secretary of the American Antiquarian Society at Worcester, Mass., in his article in the *Smithsonian Contributions* for 1855, vol. viii, has referred to an instance of an intrenched fort made by the Arickarees, in a bend of the Missouri River, above Council Bluffs. The description of this fort by Lewis and Clark does not give it the character of an earthwork with ditches for defense. It was a temporary breastwork of logs and earth and stone, hastily thrown up, such as are common in Indian warfare, and in all warfare.

The Indian forts which were attacked by Champlain in northeastern New York in 1609 were constructed of pickets set in a low bank, strengthened by interlacing branches and poles, secured by bark and withes. During the French wars with the Iroquois, on the waters of Lake Ontario, they met with nothing more advanced than these light stockades. The pickets were set in the earth, and the bank raised against them from both sides, to give them a more firm support. In no case was the bank or ditch relied upon as a protection or as an obstacle to those without. They were of a profile too slight for this purpose.

The northwestern Indians have been questioned in numerous instances as to the authors of the earthworks of the West. They universally deny having any knowledge or tradition of the persons who built them; a tradition which could not have been lost, or the art of making them. The relics which are found in the mounds, in connection with the first or oldest burials, although there are resemblances, differ from the relics of the red men in many particulars. If stone axes or mauls of the Indian type have been found in the mounds, they are rare. The last-named race were not miners of copper or copper-workers. In the implements of the two races there are resemblances, especially in those which are made of flint, but no greater than in those of the ancient races in Europe, where no connection is claimed.

It cannot, however, be denied that continued investigations bring to light a strong similarity between the works of the ancient tribes of the South and the mound-builders. If the dividing line shall be broken down as to them, there is a wide difference between the northern tribes and the mound-builders.

Col. C. C. Jones, of Atlanta, Ga., in his valuable work on the Southern Indians (1874), has given historical proof to show that the Spaniards were witnesses to the erection of such mounds.

Most of the above descriptive matter is an abstract of my remarks at the Chicago meeting of the American Association, in August, 1871, before the appearance of the book of Colonel Jones. The drawings used at the meeting have been reduced by photograph for this paper. I take pleasure in referring to his work (pages 137 to 143) for details not in my description, especially the artificial ponds *DD*, and the mound *E* inclosed by the moat. The cavities *E E E* of my sketch are the ponds *P* of Colonel Jones, but at the time of my visit were without water. There is but one ascent to the platform *A*, which is represented at 1, *e j*, and is in very good condition. Fort Hill no doubt had a relation to this group of mounds answering to the high places of worship which are common in Palestine.

## NEW RIVER MOUNDS, BERRIEN COUNTY, GEORGIA.

BY WILLIAM J. TAYLOR, of Nashville, Ga.

The mounds described in this paper, two in number, are situated on a dry sandy level of pine and oak land near the edge of a hummock which skirts the creek in the ninth district of Berrien County, Georgia. They are about 300 yards from the creek and 100 yards from a branch emptying into the creek. This site is on lot numbered 275, and 6 miles southwest from the town of Nashville.

The mounds had been partially explored previously to our examination, but the following is an account of our results:

Mound No. 1 was 30 feet wide and 4 feet high, and perfectly circular at the base. The earth composing it was obtained from a saucer-shaped excavation, now 8 feet across and 1 foot deep. At the bottom of this depression were found charred wood, ashes, and pieces of burnt pine wood, which appeared to have been placed there when the interment was made.

Mound No. 2 resembled No. 1 in every respect. The growth on both mounds were wire-grass, sedge, bushes of the red oak and post oak. The early settlers and the Indians whom they encountered were alike ignorant of the origin of these relics of the past.

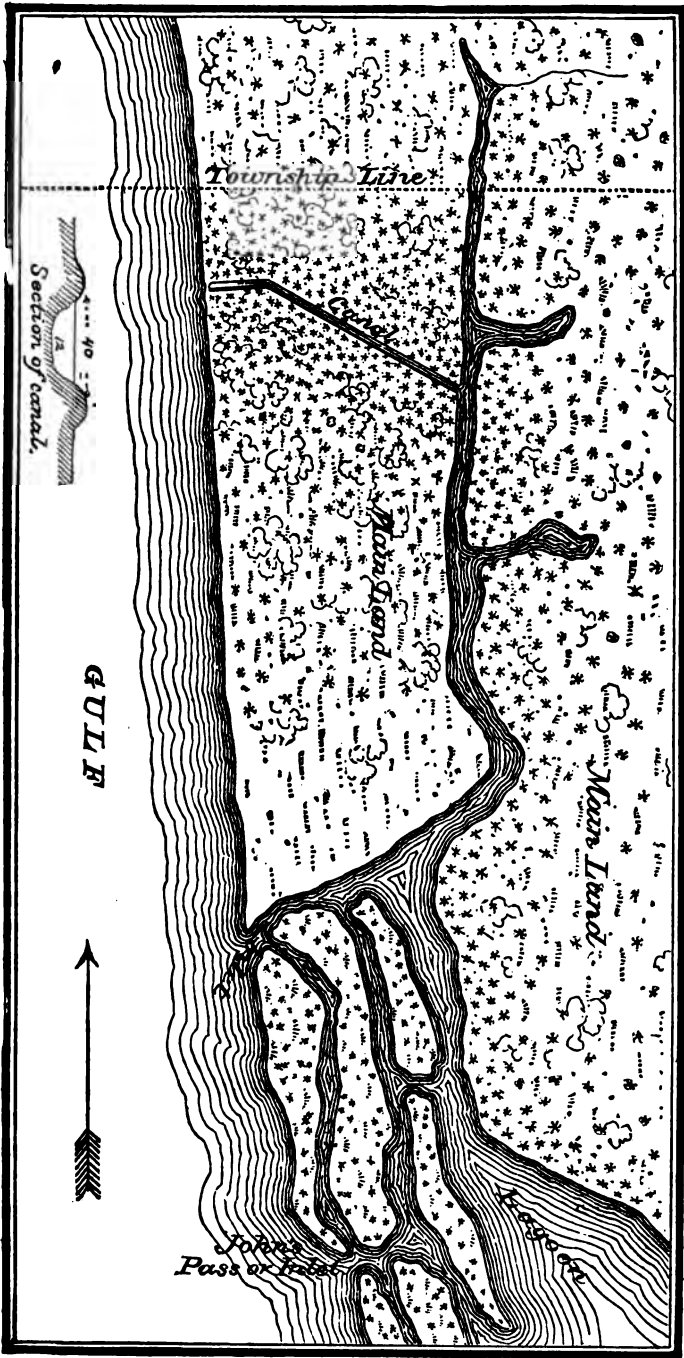
## ANCIENT CANALS IN FLORIDA.

BY CHARLES J. KENWORTHY, of Jacksonville, Fla.

In November and December, 1877, I indulged in a sail-boat cruise from Key West to Cedar Keys, and *en route* found and superficially examined an ancient canal in township 50 south, range 25 east. The accompanying drawing gives a sketch of the locality.

The canal is at present 12 feet wide at the bottom, and about 40 at the top. The embankment on each side is about 4 feet higher than the original surface. Engineering skill was manifested in laying out the canal, for its first 600 feet are at right angles with the coast line, after which it trends to the eastward. Those canals were not erected by our indolent Indians, and in my opinion they were made by another race. Three years ago I made a boat trip from Cedar Keys to Charlotte Harbor, on Lake Okeechobee. On my return I superficially examined a canal at Pine Island, Charlotte Harbor.

Some of the largest mounds in the State have been constructed near the southwest end of the canal. In my opinion the mounds have been made since the canal was excavated. I was anxious to make an examination to determine the date of the mound-building as regards the canal,



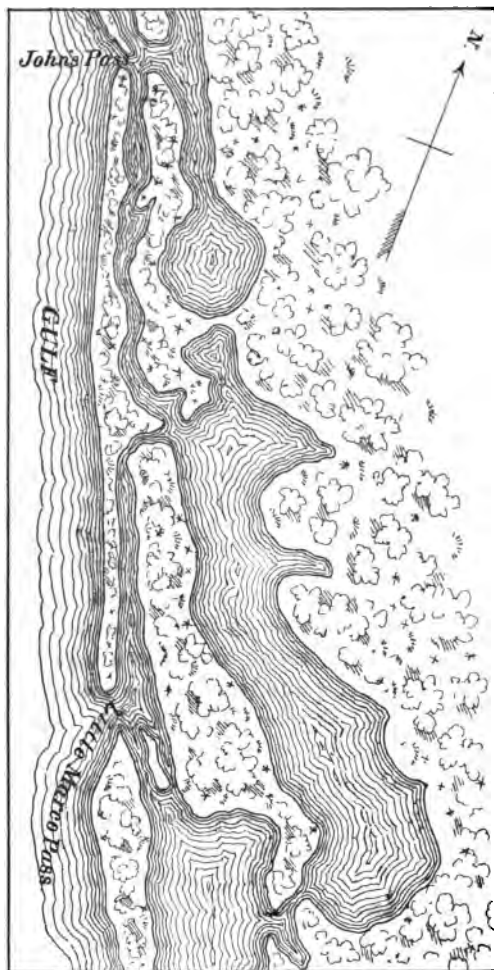
PLAN No. 1.

but my companions would not stop. I was assured, by a gentleman who had resided on the island for 24 years, that the canal extended across the island a distance of 3 miles, and that it could be traced inland (from the shore of the mainland) a distance of 14 miles. A canal similar in character exists between the falls at the head of the Caloosahatchee and Lake Okeechobee. An old coaster informed me that he had discerned an ancient canal on one of the Thousand Islands south of Cape Romano. Those excavations are evidently very old and not the work of Indians. They were not constructed for defensive purposes, but evidently for canals.

In his examinations, Professor Wyman did not visit the large mounds of the State. The largest of those standing are to be found on Pine Island and Gasparilla Island, Charlotte Harbor, at Old Fort Centre, Fish Eating Creek, on the plain between New Fort Centre and Fort Thompson, and between Fort Myers and Cyprus Bay. The mound at Old Fort Centre is about 50 feet high. It was evidently used for burial purposes, and if an excavation was made many things might be collected. I used a stick, and with a few minutes' scratching I found bones everywhere. The largest and most interesting mounds in the State have escaped notice and examination. From the immense number and large size of the shell heaps on the southwest coast, this section must have been inhabited for a long period by a large population. The distribution of the shells in some of the heaps led me to believe that the inhabitants were governed by some law. In some of the heaps you will find a layer of conch shells several feet in thickness, and above or below a layer of oyster shells. The largest number of shell mounds are to be found on the Nelt River, a lagoon or river connecting Crystal and Henoosana Rivers.

In my wanderings I found a remarkable shell deposit on the shore of Orange Lake. I noticed an elevation on the flat near the shore of the lake, covering over an acre and about 6 feet high. I noticed on the surface fragments of oyster shells. I obtained a grubbing hoe and made an excavation about 2 feet deep, and found a bed of oyster shells. They differed from other shells I have examined in other portions of the State. As far as examined, each shell had been broken at the end, as oysters were opened some years ago. The present elevation of Orange Lake is 48 feet 8 inches above the ocean level. The nearest oyster bed is distant 43 miles. This immense heap of shells was not transported 43 miles, but in my opinion were obtained from Orange Lake when it was a bay or estuary of the sea. From my investigations I feel assured that the oysters were collected and eaten when the State of Florida consisted of a belt of high land extending from the Chattahoochee to a point south of Sumterville, and before the balance of the State attained its present elevation above the ocean. If my views are correct, Florida was inhabited a long time ago. If the shells referred to have not presented the endeavors of man's work I might have referred the

collection to other causes. Two years ago I made the acquaintance of a very intelligent gentleman residing near Sumterville. Four years ago he was out deer hunting with dogs on the shore of Lake Charleossos-



PLAN No. 2.

ing the peninsula, inlet, lagoon, islands, and canals. Plan No. 2, on a smaller scale, shows John's Pass and Marco Inlet.

One mile and three-quarters south of Doctor's Pass is John's Pass, with three inside channels connecting them. Three miles and a quarter south of John's Pass is Little Marco Inlet, with an inside channel connecting them.

The land on the peninsula traversed by the canal is low, and poor pine land, not over 4 feet above high-water mark. From a passing examination of the mainland east of the lagoon it presented the appearance of low pine land unfit for cultivation. It is evident that no

skie. He was riding over an elevated hummock surrounded by a large sun-grass swamp, and discovered traces of old cultivation. Looking about, he discovered a heap of ancient pottery, which, he assured me, amounted to several cart-loads. He dismounted and examined a number of the vessels, and found that a hole had been made in the bottom of each to render it useless. After examining a few of them he followed in pursuit of his dogs. It seems to me that this hummock must have been the resort of a tribe of Indians, and when attacked by enemies they rendered their most valuable utensils useless to the enemy.

He had in the city, some months since, a large molar tooth weighing 9 pounds. It was picked up near Sumterville. On some of the tributaries of Pease Creek huge bones are visible in the sand bars at low stages of water.

Plan No. 1 is an accurate sketch of the locality, show-

large settlement ever existed in the neighborhood of the canal. Unless marked changes have occurred in the land by the opening of passes since the excavation was made, there is no apparent reason why so much labor was bestowed on the work.

Along the Gulf shore, for a distance of 150 feet inland from high-water mark, there exists a flat sand bank about 4 feet above the general surface of the peninsula, and this deposit has apparently blocked up the Gulf end of the canal. The canal at the head of the Caloosahatchee connects with the river and ends abruptly inland.

The canal crossing Pine Island is less than 4 miles from its northern end, and there is no apparent object why the excavation was made. The width, depth, and general appearance of all the canals are the same.

### MOUNDS IN ALACHUA COUNTY, FLORIDA.

BY JAMES BELL, of Gainesville, Fla.

There are at least fifty mounds within 20 miles of Gainesville, Florida. The accompanying sketch gives the location of six which have been examined, and of which the descriptions are given in this paper.

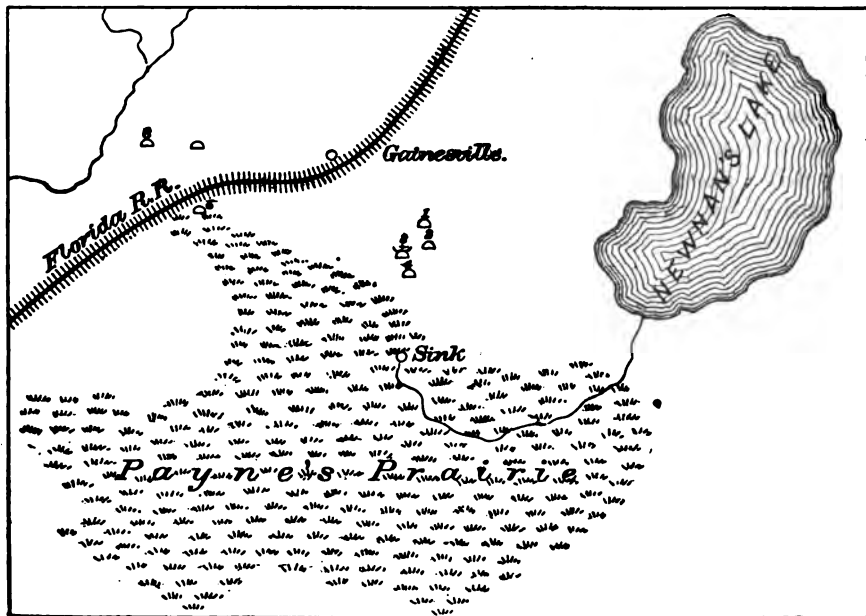


FIG. 1.

Mound No. 1 was 7 feet high and 30 feet in diameter, and located in a cleared field which has been plowed over for the last twenty years.



A shaft was sunk below the original surface. Openings were also made in the sides. But no relics whatever were found.

Mound No. 2 is situated in the same field 300 yards north of No. 1. It was at the time of its examination 10 feet high and about 95 feet in base diameter. Like No. 1, it had been much plowed over. A shaft was sunk in it below the base and extended laterally, but nothing was found excepting a few fragments of charcoal and pottery.

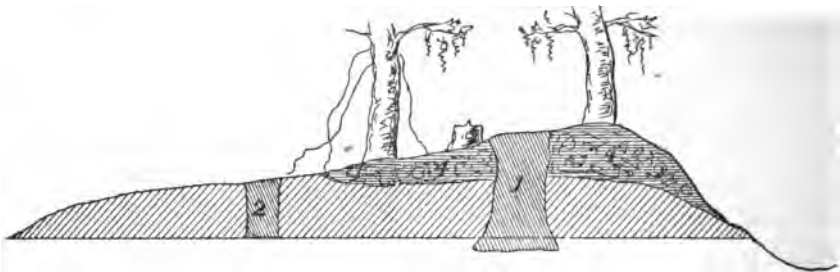


FIG. 2.—Mound No. 3—looking north (1 and 2=shafts; 4, 4=pottery).

Mound No. 3 is upon a hummock near its edge. It measures 12 feet in height, and 105 by 70 feet in base diameter. Being situated on the slope of the hummock, the summit of which overlooks the mound, this work seems to have escaped observation. A family living only 30 yards distant were very much surprised to find it a burial mound. Two large trees were growing on the top at the time of my visit, and the entire surface was covered with a dense growth of bushes and grape-vines. The accompanying sketch will convey a clear idea of its appearance. A shaft 6 feet in diameter was sunk to the original surface. After digging down about 10 inches broken pottery was encountered in great quantities, but so much shattered that it was impossible to restore a single vessel.

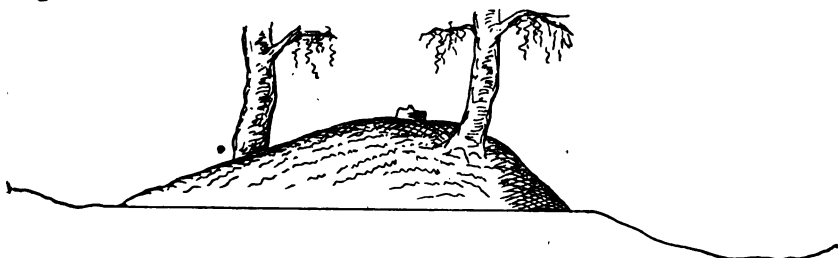


FIG. 3.—Mound No. 3—looking west.

The first bones were found about 15 or 18 inches from the surface. This stratum extended over the mound for a space 30 feet in diameter. There appeared to be three tiers of bones about a foot apart. The bodies had not been buried here; the bones seemed to have been thrown in promiscuously.

Being compelled to abandon my work for a season, other persons dug

into this mound and recovered some valuable pottery. One large basin was made in imitation of a duck with wings and bill exposed.

Resuming the exploration, the surface was dug over for a space of 30 feet in diameter and 5 feet deep. Within that area not less than one thousand skeletons were exhumed and at least two wagon loads of potsherds. This pottery commenced about a foot from the surface and extended down to the first stratum of bones.

Mound No. 4 was only 4 feet high and 15 feet in base diameter. Upon examination it was found to contain no relics.

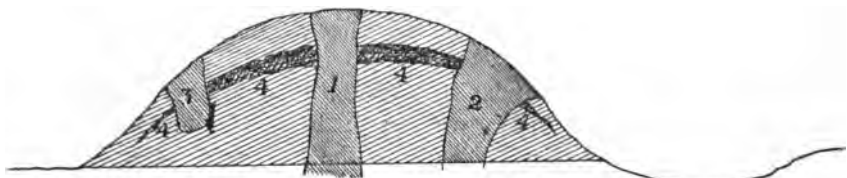


FIG. 4.—Mound No. 5—looking north (1, 2, 3=shafts: 4, 4, 4=charcoal and ashes.)

Mound No. 5 was 10 feet high and 32 feet in base diameter, and very symmetrically shaped. It was situated on a hummock about 50 yards from the margin of the arm of Payne's Prairie. This was formerly a lake, but about twenty years ago the water disappeared through the sink. It remained dry for about three years, when it filled with water and has remained a lake ever since. This mound was examined (see Fig. 4) and a stratum of ashes, charcoal, and charred bones encountered 3 feet from the surface.

Mound No. 6 was about 8 feet high and 80 feet in base diameter. It stood in a cleared field which had been plowed over for a number of years. Nothing was discovered within it, although a ditch was cut through from one side to the other.

## SHELL DEPOSITS AT THE MOUTH OF SHORT CREEK, WEST VIRGINIA.

BY H. R. HUBBARD, of Wheeling, W. Va.

Short Creek is a little stream that enters the Ohio River 9 miles above the city of Wheeling, and the shell deposit alluded to commences to show in the bank of the river some 50 yards above the mouth of this creek, and is exposed for over 100 feet up the river, when it is hidden by a fill for a road down to the water. The shells are those of the fresh-water clam and are very fragile, splitting into fine scales on handling, though an occasional one is found that is perfect. The shells are now covered with about 3 feet of silt, and formerly there were 3 or 4 feet of the same loamy deposit over this, but it was removed in grading for a public road. A portion of this road, with much of the deposit of shells, has fallen into the river by the caving in of the bank.

While many of the usual indications which mark such deposits as artificial, such as the remains of fires, &c., are present, there are two peculiarities worthy of especial notice. One of which is a stratum of river boulders which divides the deposit of shells, which is over 2 feet in thickness, into two very equal parts through its entire exposure. These boulders were evidently selected with great care for uniformity in size and are about 3 inches in diameter, and are packed as closely as in a pavement. The remains of the fires show both above and below these boulders, but none immediately upon them. The other peculiarity is the abundance of human bones found mixed with the shells, but these are probably of later origin, and, if so, show that the place has subsequently been used for a burial place.

The large mound at Moundsville, W. Va., was opened in 1838 by Mr. Tomlinson, who, in opening, drove two shafts into it, one on the plane of the base to its center, the other from the top to the base. The horizontal shaft was through a loamy clay as far as driven, which was some 12 or 15 feet at the time I was there, and for 3 or 4 feet in from the surface on the sides and top was marked with fine dark lines which formed segments of circles springing from each other in successive rows, after the manner of what is sometimes termed the "shell-pattern." These lines were from 12 to 16 inches from point to point of contact and  $2\frac{1}{2}$  to 3 inches apart at their greatest vertical separation. These lines suggested the idea that the mounds had been faced with turf. In support of this hypothesis, it would be necessary to remember the high angle of elevation of the faces of the mound, the height of the mound and the material of which it is composed, and while the angle of inclination of the faces is no more than nature willingly tolerates under such circumstances, yet, unless the faces were protected, they would be much wasted and gullied by the rains before they would be protected by spontaneous vegetation. The adaptation of the means to the end is apparent in the facility with which the material could be obtained and applied, and in the perfect protection which such a casing would afford.

## ANTIQUITIES OF SOUTHWESTERN PENNSYLVANIA.

BY REV. HORACE HAYDEN, of *West Brownsville, Pa.*

In view of the fact that in the States of Ohio, Indiana, and especially Wisconsin, ancient remains have been so carefully investigated, it must appear strange that the many *indicia* of a prehistoric race in the western part of Pennsylvania and in the State of West Virginia should be so little known. At the present date these *indicia* have been largely decreased by vandalism and by the action of the elements. Many mounds have been plowed down to the surface of the surrounding ground or leveled to make way for towns. Many of the remark-

able sculptured rocks have been used for building purposes or are lying below the surface of the Monongahela River, even at low tide, the river being higher now at all seasons by reason of the slack-water improvements than it was forty years ago. The second geological report of Pennsylvania contains nothing on the subject of antiquities; Dr. Creigh, in his "History of Washington County," is entirely silent as to the numerous mounds, &c., which are found in the county limits; and the centennial volume of the "Resources of West Virginia," by Prof. M. F. Maury, ignores the many and exceedingly interesting remains in that State. I shall here, however, give simply an account of the antiquities of Fayette County, Pennsylvania, and, in another paper, of those in parts of West Virginia. This account will necessarily be taken largely from an unpublished work by Hon. James Veech and Freeman Lewis, the latter an old and experienced surveyor of Brownsville, Pa. Remains of embankments or "old forts" are numerous in Fayette County. The Indians known to us could give no satisfactory account of them. While the trees of the surrounding forests were chiefly oak, the growth upon and in the old forts was generally of large black walnut, wild cherry, and locust. Some indicate an age of three hundred to five hundred years, and some stood around the decayed remains of others. Judge Veech thinks they were originally composed of wood, as their *débris* is generally a vegetable mold, no stone being used in their construction. Old pottery, made of clay and mussel-shells, is always found among these ruins. The old forts were of various forms, square, oblong, triangular, circular, and semi-circular. Their sites were generally well chosen in reference to defense and observation, and, what is a singular fact, they were very often, generally in Fayette County, located on the highest and richest hills, and at a distance from any spring or stream of water.

One of these "old forts" was on the land of William Goe, near the Monongahela River, and just above the mouth of Little Redstone, where afterwards was a settlers' fort, called Cassell's or Castle Fort.

Another was situated at the mouth of Speers Run, where now stands the town of Belle Vernon. Two or three are found on a high ridge southwardly of Perryopolis, on the State road, and on land lately owned by John F. Martin.

Another noted one is on the west bank of the Youghiogheny River, nearly opposite the Brood ford, on land lately owned by James Collins. There are several on the high ridge of land leading from the Collins fort southwestwardly towards Plumsock, on lands of James Paull, John M. Austin, John Bute, and others, a remarkable one being on land lately owned by James Gilchrist and the Byers, where some very large human bones have been found.

There is one on the north side of Mountz Creek, above Irishman's Run. A very large one, containing 6 or 8 acres, is on the summit of Laurel Hill, where the mud pike crosses it, covered with a large growth of black walnut.

One especially noted as containing a great quantity of broken shells and pottery existed on the high land between Laurel run and the Youghiogheny River, on a tract formerly owned by Judge Young, and remains of the fort are to be seen. There are yet distinct traces of one on land of General Henry W. Beeson, formerly Colonel McClean's, about miles east of Uniontown.

There was one northeast of New Geneva, at the locality known as the "Flint Hill," on land now owned by John Franks.

Two miles northeast of New Geneva, on the road to Uniontown, and on land late of William Morris, now Nicholas B. Johnson, was one celebrated for its great abundance of mussel-shells. In the high ridge southwardly of the headwaters of Middle Run several existed, of which may be named one on the Bixler land, one on the high knob eastwardly of Clark Breeding's, one on the Alexander Wilson tract, and one on the land of Dennis Riley, deceased, formerly Andrew C. Johnson's. Judge Veech also states that "a very noted 'old fort' and of most commanding location was at Brownsville, on the site of Fort Burd, but covering a much larger area. Even after Colonel Burd built his fort here, in 1759, it retained the name of the 'Old Fort,' *Redstone Old Fort, or Fort Redstone.*" I am quite sure that Judge Veech is in error in locating this old fort on the site of Fort Burd.

Of the antiquities immediately around Brownsville no trace at present remains. On the original draught of Fort Burd, made by Major Joseph Shippen in 1759, and now in the possession of the Historical Society of Pennsylvania, can be seen, immediately to the rear of Fort Burd, the old Indian Fort, which is now so entirely obliterated that very few remember where it was located. The fullest description of this earthwork is found in "Travels in America, performed in 1806, for the purpose of exploring the rivers Allegheny, Monongahela, Ohio, and Mississippi, &c., by Thomas Ashe, esq., London, 1808." In the fifth letter of this work the author says:

"The neighborhood of Brownsville or Redstone abounds with monuments of Indian antiquity. They consist of fortified camps, barrows for the dead, images and utensils, military appointments, &c. A fortified camp (which is a fortification of a very complete nature, on whose ramparts timbers of 5 feet in diameter now grows) commands the town of Brownsville, which undoubtedly was once an Indian settlement. This camp contains about 13 acres, inclosed in a circle, the elevation of which is 7 feet above the adjoining ground. Within the circle a pentagon is accurately described, having its sides 4 feet high and its angles uniformly 3 feet from the circumference of the circle, thus leaving an unbroken communication all round. Each side of the pentagon has a postern opening into the passage between it and the circle, but the circle itself has only one grand gateway, which directly faces the town. Exactly in the center stands a mound, about 30 feet high, hitherto considered as a repository for the dead, and which any correct observer can perceive to have been a lookout. I confess that I examined

these remains of the former power of man with much care and veneration; nor could I resist reproaching those writers who have ignorantly asserted, 'We know of no such thing existing as an Indian monument of respectability, for we would not honor with that name arrow-points, stone hatchets, stone pipes, half-shapen images, &c.'

"The one which I have opened might have been originally a parallelogram 60 feet by 20, and 30 feet high, whose upper surface and angles have been rounded by the long influence of time and accident; for we are not to conceive that the form of ancient works is exactly similar to that which they first possessed. Such, indeed, as are built of stone and have not been exposed to dilapidation do not experience any material change; but all those monuments (and they are by far the most numerous) which are composed of earth must have undergone considerable alteration and waste, and therefore afford a very scanty evidence of their original dimensions, or (except where bones are found) of their purpose. The bones in the barrows of this neighborhood were directed to every point, without regard to system or order. This surprised me more as I am well convinced that in general most of the ancient aboriginal nations and tribes had favorite positions for their dead, and even favorite strata with which to cover them, as I shall have occasion to explain when on the spot where the primitive Indians resided. Perhaps the irregularities in the barrows of this place may arise from the bones deposited in them, having been those of persons killed in battle, and collected by the survivors in order to be buried under one great mound. . . . At the same time and place I found in my researches a few carved stone pipes and hatchets, flints for arrows, and pieces of earthenware. I cannot take upon me to say that the workmanship of any of these articles surpasses the efforts of some of the present race of Indians, but it certainly destroys an opinion which prevailed, that the inhabitants in the most remote times had the use of arms, utensils and instruments made of copper, iron, and steel."

Josiah Priest, in his *American Antiquities*, 1833, p. 85, mentions this ancient fort, but he uses the language of Ashe without giving credit. Mr. James L. Bowman, who had frequently seen the outlines of the camp, notices it briefly in "*Day's Historical Collections*" and the "*American Pioneer*."

Curiously carved rocks are to be seen on many parts of the Monongahela River. At the mouth of Ten-Mile Creek, 12 miles above Brownsville, are the most interesting of these. Some of the rocks there bear the impress of a man's foot, a horse's foot, a hand, a head, a turkey, a fish, birds, beasts, &c.

On the farm of Mr. George. E. Hogg, near Dunlap's Creek Church, 5 miles east of Brownsville, there have been found a vast number of flat stones, soft and friable, which are full of small circular indentations of various diameters, as if made by the attrition of some harder substance, rubbed between the hands. Possibly they were used to produce fire by rubbing pieces of cane in them rapidly between the palms of the hand.

## ROCK-CARVINGS ON THE SUSQUEHANNA RIVER.

BY F. G. GALBRAITH, *of Bainbridge, Pa.*

The rock referred to in this paper was originally 71 feet in length and 10 feet in width. Seventeen feet on the west and 16 on the east remain undisturbed. The center, 38 feet in length, was blasted away many years ago, and the stone used in the construction of a shad-fishery, by which many carvings were undoubtedly destroyed, traces of which I discovered upon fragments of rock lying scattered over the upper end of the island. The rock was evidently a continued mass of sculpturing, and hundreds of these may yet be traced with a little care. A large portion of the east end is becoming detached from the main body, and will in the course of a few years topple over, face foremost, into the river. Many of the carvings, which are undoubtedly of a very remote date, are much defaced by the elements. This statement relates more particularly to those on the north and east ends, which I impute to the changing in the course of the stream at this particular point. The rock being located at the head of Grey Rock Falls, is subject to much wear by swift water. For this reason, and the fact that the rock is composed of talcose slate, it is my impression that the carvings were originally deeply cut, which evidence can again be traced in the east and south end carvings, all of which are much deeper than those on any other portion of the rock. The large circular carving is the only one traceable by compass on the rocks, and faces "nine o'clock, sunrise." The tracings were all taken by actual measurements from dead-lines made upon the rock, one perpendicular through the center of the carving and another across. The one from which the tracings were made is slightly enlarged to show it more plainly. The small island (a fishery) which it connects is probably 80 feet long by 20 broad at its widest point. The large rock on the opposite side of the middle channel is about 150 yards distant, having several carvings upon it. I am unable to say whether the spring and fall floods rise sufficiently high to cover the large projecting rocks below the small island so as to change the course of the stream at that point, but do not think so, as the fall of water is about 8 feet to the mile. Mr. French informed me, however, that the rock and island were accessible in very dry seasons, so that it does not appear necessary that boats should have been brought into requisition by the natives, or if so, only in case of high water, while at work upon the rock. The outer rock can only be reached by boat.

## CHAUTAUQUA COUNTY, NEW YORK.

BY JAMES SHEWARD, of *Dunkirk, N. Y.*

Chautauqua County has furnished many indications of a former occupancy; but, as yet, we have found nothing to establish its probable antiquity.

I have some fragments of a piece of pottery, a jar or vase, found beneath the roots of a very old apple-tree in the town of Stockton. This tree grew in a valley, and was evidently quite old when it was blown down. The vase or jar was broken, but it was estimated, from the pieces found, to be about two gallons capacity. The pieces indicate that it was made principally from pounded quartz. The surface was smooth and impervious to water. The depth at which it was found I have been unable to ascertain with any certainty. Thus far I can find no evidence of a secular increase in the valley; consequently there are no data for a calculation of the period when the jar was abandoned. The fragments and description were given to me by Mr. F. McCullough, of Delanti, this county. Within the village of Frewsbury, town of Carroll, some years ago, a pine stump, which had been left standing for a long time, was pulled up, and under its roots were found two human skeletons. I saw some of the bones were parts of the skull, but was unable to determine whether the crania indicated round, flat, or oval-shaped heads. I could obtain no certain information as to the depth below the surface at which these bones were found, and none as to secular increase. The pine stump was very large and showed 580 cuticle layers or growths. The tree at the time it was felled was five hundred and eighty years old, and was probably cut down twenty years or more before the stump was pulled up. A period of six hundred years must have elapsed since that tree began to grow. How long those skeletons have been inhumed prior to the germination of the tree we cannot tell. At the first settlement of that section of our county the valley was a vast pine forest. Through this valley runs a creek or brook, tributary to the Conawanga, one of the tributaries of the Ohio. I have reason to think that a thorough exploration of this neighborhood would give valuable information.

In the town of Sheridan, on the farm of Mr. N. Gould, have been found, at various times, numbers of human bones. These bones indicated, by their number, size, and position, that the place where they were found was either a cemetery or had been the scene of a battle where large numbers of all ages and sexes had been killed. The craniological developments I know nothing about. In the vicinity of Mr. Gould's farm are yet to be found earthen fortifications, breastworks, and ditches. These fortifications are somewhat numerous and exten-



sive, reaching over into the town of Perufret, where a hill, known now as Fort Hill, gives unequivocal testimony of the work of man. Between Fort Hill and Mr. Gould's farm is found a hill about 30 feet high, with a circumference at its base of about 90 paces. The top of this hill is flat, oval in outline, and composed, as far as examined, of the material constituting the surface formation of the plain. The hill may possibly have been formed by currents of water, but there is no bluff or bank near it. It stands about 3 miles inland from the lake, and was originally covered with large forest trees in nowise differing from the trees of the surrounding plain. Mr. Gould, over seventy years of age, says he well remembers the hill as it was in his childhood, and that it was so conspicuously above the surrounding trees as to be regarded as a landmark by early navigators of Lake Erie. He describes one tree, which grew near the top of the hill, as being 4 feet in diameter. Careful examination of the plain gave no depression in the surface to indicate that the earth which composes the hill was excavated there. I am inclined to the opinion that the hill is in reality a mound, and that it was in some way connected with the other fortifications already mentioned. In this connection I may mention that some years ago, in plowing a field on his farm, Mr. Williams, of the town of Sheridan, turned up as much as two bushels of flint spalls or chips, and a number of arrow and spear heads. These were pretty much all together, and led Mr. Williams to suppose that Indians made their tools there. Some of these implements, in outline and material, very nearly, if not entirely, correspond to those found in Ohio, near what is called Flint Ridge. I believe that flint or chert is not to be found in this county. Whether the crude stone was brought to the place where the flints were found, and was there worked into shape, cannot be settled as yet. Some fifty-odd years ago I saw a large field in what is now the city of Zanesville, Ohio, plowed up for the first time. The whole field was dotted over with flakes, spalls, arrow and spear heads, stone hammers, and axes, indicative of a manufactory. Old and partly decayed stumps were overturned or pulled up and the spalls were found under them. From this field to Flint Ridge there was nearly a continuous water communication. There are grounds for believing that the material was originally quarried at Flint Ridge, where numerous excavations, partially filled up, are to be found, and having trees growing in them. Whether the persons or people who wrought in Sheridan were located there we do not know, neither can we safely say that the implements found were made by those who erected the fortifications.

I have an amulet which was plowed up on the farm of Mr. Prendergast, in the town of Westfield, this county, and by him presented to me. It somewhat resembles Fig. 27 in Colonel Foster's work, "Prehistoric Races," page 222, which he calls a *totem*. His totem was found in Wisconsin; the amulet was found in Chautauqua County. I will give my reasons for regarding these effigies as amulets in an article now pre-

paring, entitled "An Inquiry into the Origin and Antiquity of the Indian Race." I have never yet found an Indian drawing or signature of his totem that could be at all compared to the outline of the amulet; and as there are two holes neatly drilled and rimmed for the reception of a thong or cord, I am inclined to think that no *Indian* made it, and that it belonged to a people of superior taste and skill. He who made and polished it was an expert workman, and could not have been a hunter or a warrior of the Indian kind. I have a stone gouge of admirable construction, which was plowed up in the town of Sheridan and given to me by Mr. Griswold. Like the amulet, it must have been made by an expert. The stone is hard enough to carry quite a fine edge, and the tool gives evidence of having been much used on wood. It is supposed that it was used for tapping the maple tree. I have some other implements found in this county, one in the shape of a celt, which, a Seneca Indian told me, was used by his people for skinning animals.

Chautauqua Lake lies within this county, and many relics have been found along its shores. At one place Long Point juts out into the lake, forming a long, narrow neck of land, which used to be fringed with bushes and covered with stately trees. On this point, near its outer extremity, there had been a canal and basin excavated. A party or a person could easily double the point in a canoe, part the bushes and paddle through the canal and into the basin, where they were perfectly hidden from view. I saw the remains of this canal and basin about seventeen years ago; the outlines were then quite distinct. These works, however, are not proofs of a settled population.

The Iroquois knew all about our territory; indeed, they gave the name to the lake, Cha-tau-quah, or "bag tied in the middle." In a written speech, prepared by *Corn-planter*, *Half-town*, and *Big tree*, Seneca chiefs or sachems, and presented to President Washington, they ask their "father" if he is determined to crush them, and say, in case he is: "In this case one chief has said he would ask you to put him out of his pain. Another, who will not think of dying by the hand of his father or his brother, has said he will retire to the Chataughqua, eat of the fatal root, and sleep with his fathers in peace." This speech was answered by the President, and these chiefs replied as follows: "Father, we see that you ought to have the camping-place from Lake Erie to Niagara, as it was marked down at Fort Stanwix, and we are willing it shall remain to be yours. And if you desire to reserve a passage through the Canawauga, and through the Chataughqua (Lake), and land for a path from that to Lake Erie, take it where you like best. Our nation will rejoice to see it an open path for you and your children while the land and water remain, but let us pass along the same and continue to take fish in those waters in common with you."

There was, at an early day, a path or road from Lake Erie through the towns of Portland and Chautauqua to Chautauqua Lake, and thence to Pittsburgh, which the French and Indians traveled; but, except a

rude camp and defenses, there was no settlement nearer than Logstown, Ohio. The Senecas formed what was called the western door of the Iroquois Long-house, and claimed our county as a part of their hunting-ground. I can find no satisfactory proof of the occupancy of this territory by any tribe of Indians, unless it may have been the residence of the Kah Kwahs, a tribe said to have been driven out by the Iroquois, and which has wholly disappeared. It is claimed by some that there was once a tribe called Alleghans occupying lands in or near this county.

It appears to me that the Iroquois, admitted to be the most intelligent and powerful of all the tribes or confederacies, were never far enough advanced to construct the fortifications or to make the polished stone implements found in our county; and if they were not, was there any other people who were ever settled in this territory?

Champlain, in 1609, gives us some idea of the barbarism of the Senecas, against whom he made war. Wassenäer, the Dutch historian, in 1621-'2 represents the Indians as savages who could not have been of the "polished stone age." Cartier found them "insufferable"; so Cadillac describes them. All we can gather from historical documents leads to the belief that the stone implements, the pottery, the fortifications, the skeletons found, and the large mound (if it be one) were the work of a people existing anterior to the historic period and more advanced than the Knoshioni, or Powhatan stocks. One argument grows out of the fact that all the relics have been dug or plowed up. Stone axes, flint or chert arrow and spear heads have often been found on the surface or just below the surface of the land, while the pottery, gouge, amulet, &c., have been found at various depths. The two skeletons found at Frewsbury under the pine stump lived and died long before the "League of the Long-house" was formed. Two feet, at least, of a secular increase has grown up since these two human beings were laid away. Can we, in the absence of "monuments of known age," ever ascertain the rate of that increase? The lofty old pine tree began its life more than six hundred years ago. How long before that tree sprouted had these bodies been deposited there? And then, again, were these two dead ones members of the tribe or nation that raised the breastworks and made the implements we find at various depths below the surface of to-day?

In my search after data upon or from which to estimate a secular increase of land I have consulted many Indians and whites, but none are able to give any facts. Sa-gun-da-wie, or Big Nose, a member of the Seneca tribe, gave me an iron ax or hatchet, evidently one of the kind used by the Dutch or French to trade for furs. He told me it was plowed up on the Cattaraugus reservation from a depth of about 8 inches, but he could not say whether the plow had ever before passed over the spot. The ax must have been lost or thrown away at least two hundred years ago; it may have been two hundred and fifty years. If we were sure that the implement was left on the surface two hundred years ago, the secular increase would have been at the rate of about 4 inches per

century; if two hundred and fifty years had passed, it would have been at the rate of  $3\frac{1}{4}$  inches per century, or nearly the same as that found by Dr. Horner at Heliopolis, in Egypt. If we assume an average secular increase in our valleys of 3 inches per century, the skeletons at Frewsbury are at least eight hundred years old; they must be at least six hundred years old. I am not without hope that closer and more patient observations will, in course of time give us some reliable data upon or from which we can estimate antiquities now seemingly beyond our reach.

That Chautauqua County was once inhabited by a people more advanced than were the Indians found in the neighborhood by the French and Dutch may, I think, be assumed. That there were human beings here eight hundred or even one thousand years ago seems probable.

I think there are many reasons for the belief that the Indian race, or races, if you will, were the descendants of the Mound-Builders, notwithstanding eminent ethnologists think to the contrary.

I think our county would richly repay a thorough scientific exploration.

## ANTIQUITIES OF ONONDAGA AND ADJOINING COUNTIES IN NEW YORK.

BY W. M. BEAUCHAMP.

The best accounts of the antiquities of this portion of New York are in Clark's History of Onondaga (1849). This work treats principally of Elbridge and Pompey. General J. A. Clark, of Auburn, has published an identification of Onondaga historical sites, which is also worthy of study. Recently the Skaneateles Democrat gave an account of the finding of a clay pipe there, with human face, 30 inches under ground, in low land; the Auburn papers, of the discovery of human skeletons in Fleming; and the Syracuse papers, of the disinterring of thirty prehistoric skeletons in stone cists in East Syracuse, and of the finding of several skeletons (historic) in Onondaga Valley.

The writer has also made extensive investigations in this section, correcting some errors, and gives, in the following notes, the results of his labors and reading. The localities mentioned will be found on the accompanying chart.

### OSWEGO COUNTY.

At Fulton, on the east side of the Oswego River, were the remains of a European earthwork, constructed in the French war, and of a semicircular aboriginal fort. The other portions were removed in making the canal. Here was a noted portage. Bone Hill, now leveled, on the west side of the river, contained large quantities of human bones, and about Lake Neawantha were many arrows.

1. On the line dividing the towns of Volney and Schroepfel was an

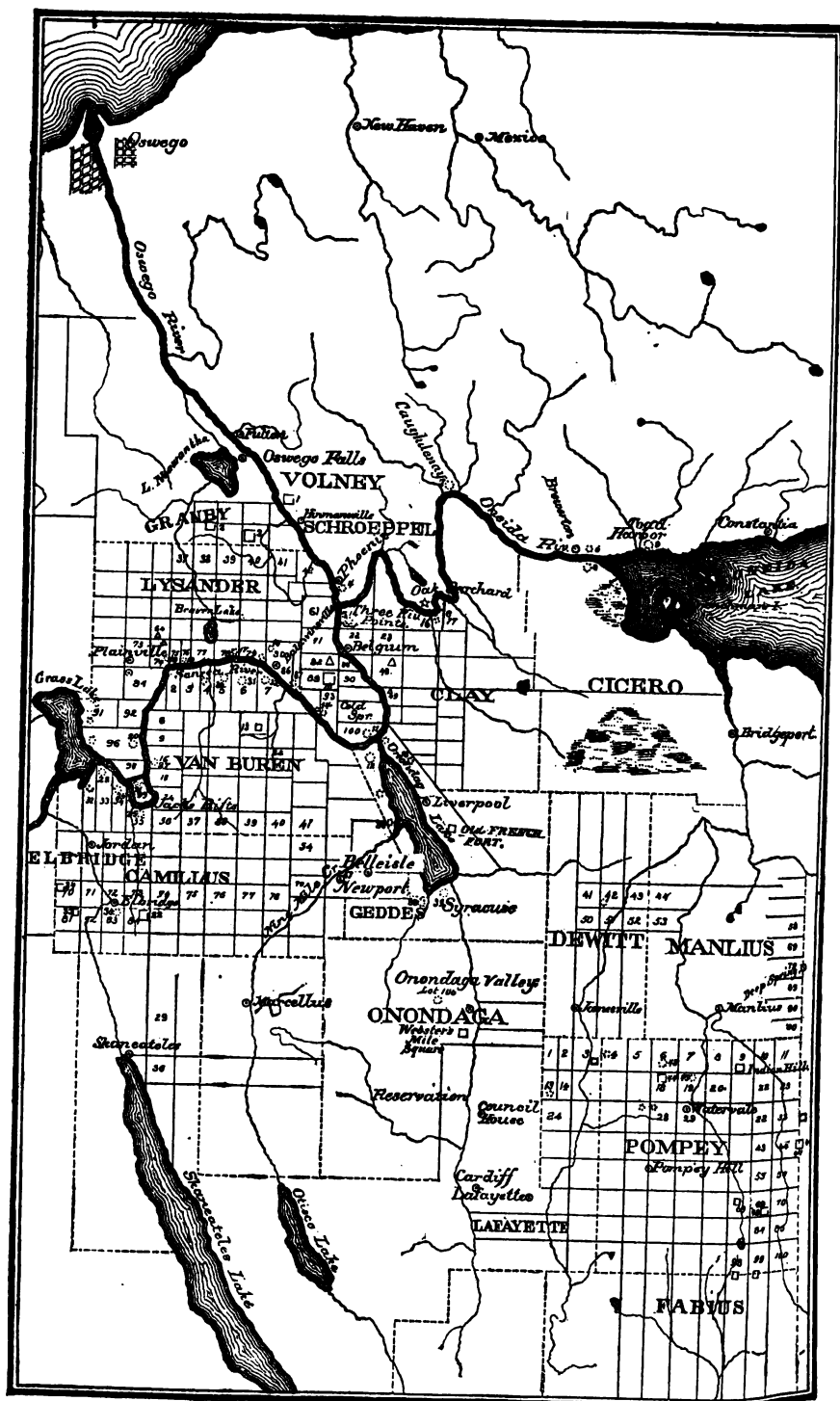


FIG. 1.

earthwork on a hill, now destroyed. A long wall, separating the hill from a marsh on the east, still remains. Arrow-heads of flint, *en caché*, have been plowed up.

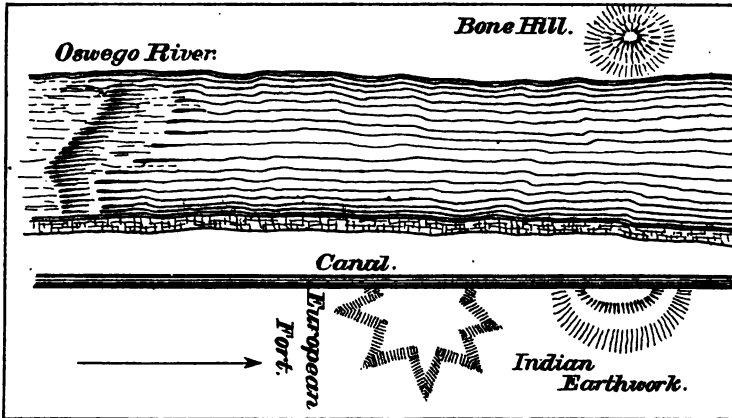


FIG. 2.

2. The remains of a circular earthwork on Mr. J. T. Geer's farm, lot 24, Granby, east of the railroad station, are in very good preservation,

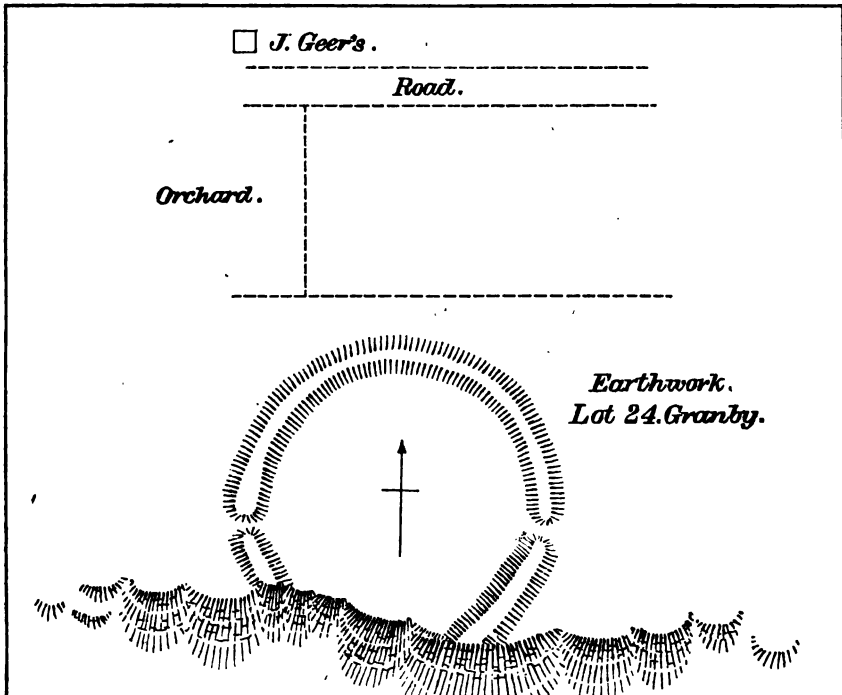


FIG. 3.

showing both gates. It yields nothing but small pieces of earthenware. The area inclosed is about an acre, and is upon a hill; Clark's estimates for this and the next are too high.

3. There was an earthwork, like the preceding, on lot 32, east of the State road, but it has been demolished by cultivation. It was on a large plain, and many fragments of pottery, celts, and clay pipes are found.

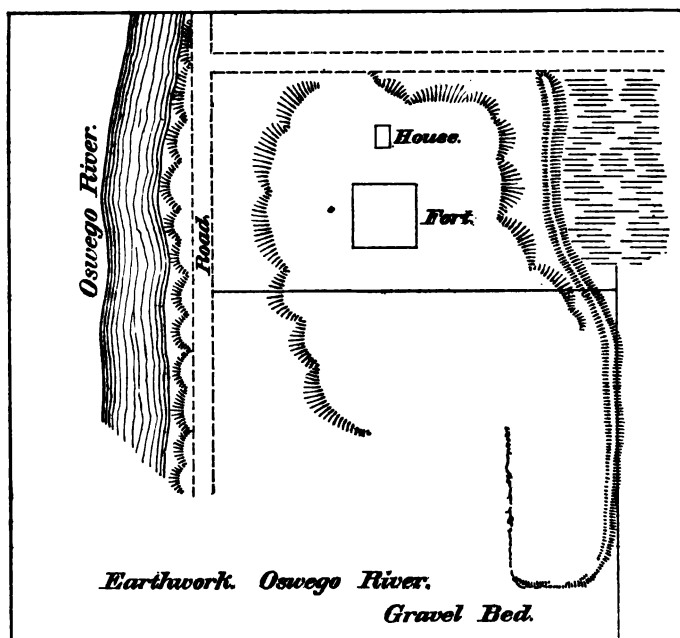


FIG. 4.

4. There were villages about Phoenix of historic and prehistoric dates. One of the most important was on a small island, where over 1,500 flint implements have been collected; scrapers, flint and quartz arrows and knives, polished slate arrows, points, celts, gorgets, and bird totems abound.

7. A village site and cemetery occur at Caughdenoy, on the Oneida River. Arrows, gouges, and fine celts have been found.

8. At Brewerton are several village sites on either side of the Oneida River, near the lake. A noted burial-place is on the north side. These villages were both historic and prehistoric, and here the walls of old Fort Brewerton are still in good preservation. Arrows, pipes, celts, gorgets, and bird totems are met with here, and between this site and Caughdenoy two fine bayonet-shaped implements of slate were discovered.

9. On the Oneida Lake, at Good Harbor, fine arrow-points, stone tubes, and gouges have been found, and there are other localities beyond.

## CAYUGA COUNTY.

52. In Brutus is the site of an earthwork, near the Seneca River, described by Squier. Fine gouges, with and without grooved backs, gorgets, arrows, and celts occur.

53. Remains of an earthwork, figured by Schoolcraft, are still to be seen on Fort Hill, Auburn. The pipes found here are peculiar. Two other sites have been identified in Auburn, and there were Cayuga settlements on Cayuga Lake, Salmon Creek, and Seneca River, mostly of the historic period. A well-known site is on Frontenac Island. Skeletons were dug up in Fleming in 1878. West of Cross Lake are sites but partially examined, and yielding coarse implements. Early sites have been found in the southern part of the county.

## MADISON COUNTY.

The Tuscarora village of Conaseraga was in this county, as well as some Oneida hamlets and villages. There is said to have been an earthwork at Cazenovia, and there are burial-places near there. The most noted site is at Nichols Pond, on the Mile strip, which is claimed as the stockade attacked by Champlain in 1615. It is a few miles northeast of Cazenovia, and presents strong points of agreement and disagreement with Champlain's picture. It is prehistoric and yields fine relics. There was a fishing village at Bridgeport, and other sites will be mentioned in connection with Pompey.

## ONONDAGA COUNTY.

*Town of Olay.*—On lot 14, near the Seneca River, was a small village and burial-place; and also on lot 16, at Oak Orchard, skeletons, tablets, arrows, pestles, celts, &c., have been found. A fine slate "bird-pipe" was picked up here in 1878; also slate arrows on lot 48, and a sandstone tube on lot 49. A fine copper celt, weighing 2 pounds 14 ounces, was recently found on lot 22.

*Town of Lysander.*—Near Belgium, on lot 82, a fine banner-stone was discovered, and also a fine and curious copper celt in 1878.

11. A village site exists at Cold Spring, lot 100. Human remains, celts, banner-stones, flint and quartz arrows are most frequent here. A bird totem, unique in form and material, has also been found on this spot.

10. On lot 89 was an earthwork, inclosing about 2 acres, within two circular ditches. Something like a wall was between these. It was on high ground, and the relics are earthenware, celts, pipes, and slender arrows of flint.

Two small hamlets were on lots 93 and 94, with similar relics, but coarser arrows; and two others occur on lots 86 and 87 (15), near Float Bridge and Railroad Bridge.

16. At Baldwinsville are vestiges of three small hamlets on the north side of the river, one of some size. The relics do not differ from those on neighboring sites.

17. A village site of two acres, probably once stockaded, occurs on high ground on lot 78. The arrows are slender and pottery fine.

18. A village site of two acres is on lot 76, where fine drills, celts, arrows, &c., are found, with banner-stones.



19. Here are three hamlets, with the ordinary relics, on lot 75, and there are others on lot 74. On this lot also was found a fine copper spear-head, and another was obtained on lot 64.

20. A village site remains on lot 96, where arrow-heads, celts, and a little pottery are found. This is on the Seneca River, and smaller ones occur at Cross Lake.

21. On lot 99 are two or three hamlets, revealing arrow-heads, hammer-stones, pestles, gouges, and celts. On the same lot was recently found a fine and very sharp copper celt. There are some smaller sites not mentioned here.

*Town of Elbridge.*—Small sites occur on the shore of Cross Lake, on lots 31, 32, and 33, with the ordinary relics.

23. Lot 34 contains the remains of a large village and one or two smaller hamlets, where arrow-heads, pestles and mortars, celts, fine gouges, and a little pottery have been found.

25. Lot 35 has similar remains on several sites, one historic. Stone pipes are found here in graves, and in a recent burial-place a fine human-headed pipe was unearthed. West of Carpenter's Brook one of the rare pentagonal arrows was found by the writer.

34. On a high hill on lot 70 was an earthwork, which Clark describes as rectangular, with two gateways, and inclosing  $4\frac{1}{2}$  acres. It really was elliptical, and inclosed a smaller area. Pottery is abundant there yet.

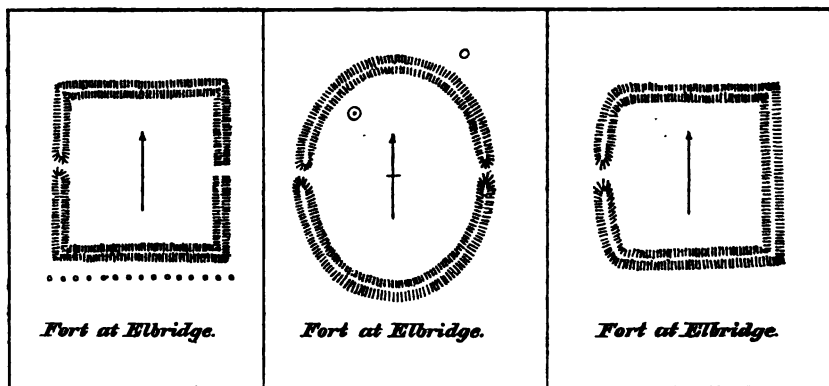


FIG. 5.

35. A smaller one on a hill on lot 81 inclosed  $1\frac{1}{4}$  acres. It is described by Clark as having straight walls on three sides and a curved wall on the fourth. It was probably also elliptical, but has been leveled.

36. On lot 83 was a large Indian village. The writer has ascertained that Clark was mistaken in saying that hundreds of grooved axes were found there. None were found, and they are very rare in Onondaga County.

37. Here was a circular fort on lot 73, inclosing about an acre.

22. On lot 84 was a circular earthwork, with two gateways, and said by Clark to have included three acres, but his estimates prove almost always too high. Earthenware always occurs in earthworks or stockades, and often river shells in the north part of the county.

*Town of Van Buren.*—26. An Indian orchard was located on lot 18.

27. Here was a small hamlet, on lot 16, with pottery, arrow-heads, and a pick-shaped banner-stone.

28. In the river, at lot 3, is a stone fish-weir in good preservation, with several bays, and formed of bowlders. Since the river has been dammed it has been generally some feet below the surface, but an unusual drought gave opportunity for full examination. There are others on the river, the Indians reserving the right to make them in their treaties.

29. An Indian orchard and burial-place were located here, one of the few recent sites.

On lot 4, west side of Dead Creek, was a hamlet.

30. On lot 8, east side of the same creek, was a hamlet of considerable size, and there are fire-places on the opposite bank of the river.

The Van Buren site yields celts, arrows, pestles, and pottery.

31. On high land, on lot 6, there is a large village site which was stockaded. Arrow-heads, celts, fine clay pipes, pottery, and one copper bead have been recovered. Close by was found a fine copper spear-head of large size.

32. Lot 7 includes at least four distinct village sites in Baldwinsville, south of the river, all of considerable size. On one was found a pentagonal arrow-head; on another a clay face luted on pottery. Here are burial-places and a great variety of prehistoric relics, including some fine pipes. At one point glass beads have been found.

33. A stockade, inclosing two acres, stood on a low hill on lot 13, by a small stream, and having one gateway. The usual prehistoric relics occur, with both stone and clay pipes. Near Memphis, lot 37, many fine articles have been found, as tubes, bird totems, slate knives, &c. Further east, on the Seneca River, are occasional small sites.

*Town of Geddes.*—12. On lot 9, west side of Onondaga outlet, are two

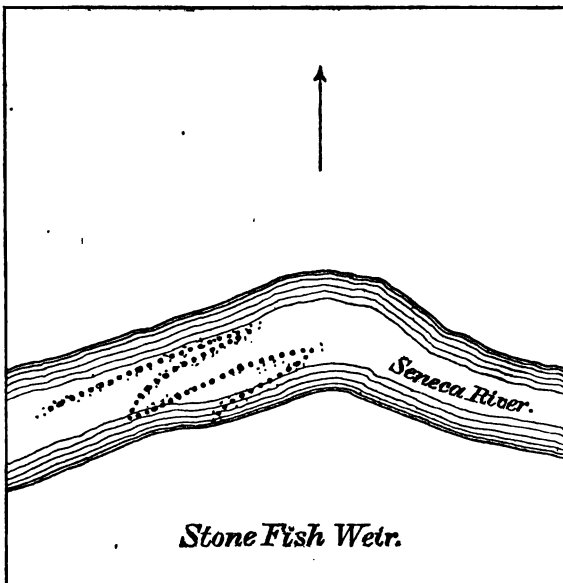


FIG. 6.

village sites, on which occur celts, banner-stones, pestles, arrow-heads, scrapers, drills, stone pipes, plummets, gouges, together with a little pot-

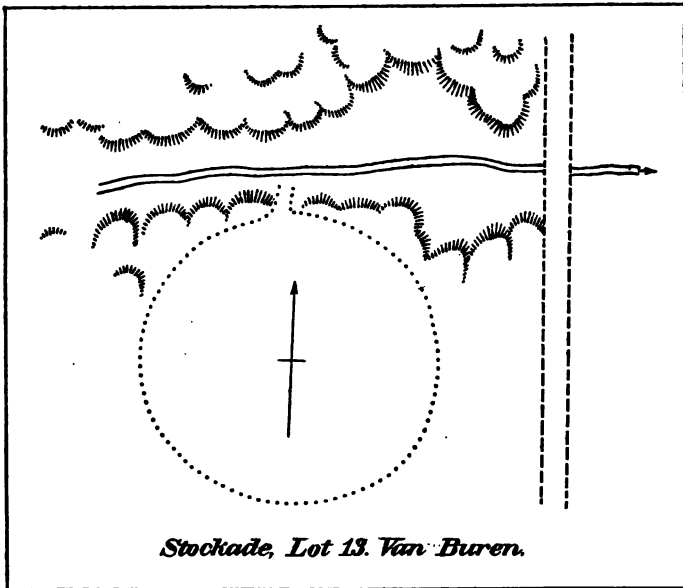


FIG. 7.

tery. Another small hamlet was east of the present outlet, and a burial-place in a gravel-bank, now removed. In the woods a little north is a small mound.

*Fort of 1696.*

38. There is a village site on the north side of Nine-Mile Creek, with arrows and pottery, and there are others still further north, with fine relics. On one of these, by the shore, the writer obtained a small cup-shaped stone pendant of very rare occurrence, the only one in the Smithsonian collection having come from California.

The site of the ancient Kan-eenda, a fishing village of A. D. 1700, was on the west bank of Onondaga Creek. Relics modern, but fine.

39. *Town of Salina.*—A scattering village stood on lots 61, 62, and 65. Pottery, banner-stones, pestles, and arrow-heads

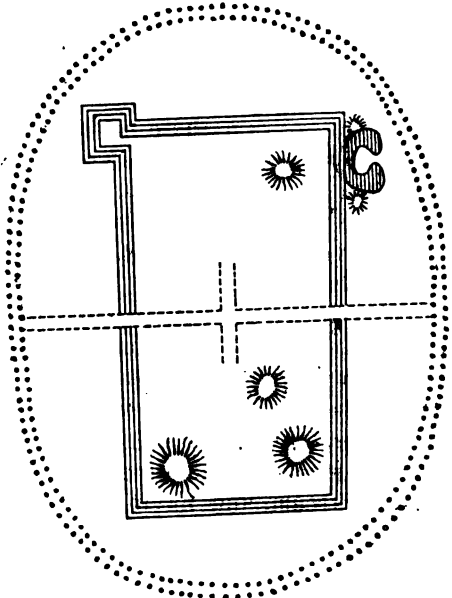


FIG. 8.

are found, and other remains occur near Liverpool, where was also a village. Bird totems have also been found in this town.

The old French fort of 1696 stood on lot 106, but traces of it can now be found only by digging. An Indian village grew up about it, and there was a burial-ground farther south. In Syracuse there were also orchards and burial-places.

*Town of Onondaga.*—Sir William Johnson built the Onondagas a stockade in 1756, which was burned in 1779. It stood on a plateau on Webster's Mile Square, and the inclined roadway by which it was reached from the creek yet remains. The writer recently examined and fully described this site. The several burial-places and other sites in this town are all modern, and yield European and Indian relics. Yet a stone plummet and a bird totem were found at the present reservation, the latter worn as an ornament by an Indian girl.

40. *Town of De Witt.*—A burial-place was discovered in East Syracuse, lot 42, in 1878, from which many skeletons were taken. They were inclosed in rude stone cists, which yielded also clay pipes, arrow-heads, and celts. Near Jamesville fine stone pipes have been found.

41. *Town of La Fayette.*—On lot 3, east side of the reservoir, is the site of the large fort destroyed in 1696, during Frontenac's invasion. It was a stockade and earthwork, and the remains are both Indian and European. Several burial-places occur in this vicinity.

42. On lot 13 was a large Indian orchard and a settlement, which was abandoned on the invasion of 1779. The relics are both Indian and European. A burial-place has the graves in rows, and also scattered promiscuously. The bodies were inclosed in boxes of wood or bark. (Clark.)

*Town of Pompey.*—This has many sites, nearly all historic, and fully described by Clark, but with some errors.

43. At this point is a village site, which had circular lines of stone and relics of mixed origin. (Clark.)

44. A little south of the last named is a burial-place, and also lines of earthworks, with similar remains. (Clark.)

45. On lot 19 was a village site with four streets and mixed relics. (Clark.)

46. On lot 9 is Indian Hill, probably the Onondaga Castle of 1650. Clark describes the settlement as about a mile long, with a burial-place of 30 acres, but makes an overestimate again. He describes the earthwork as elliptical. European relics are found there yet. It may extend slightly into lot 20.

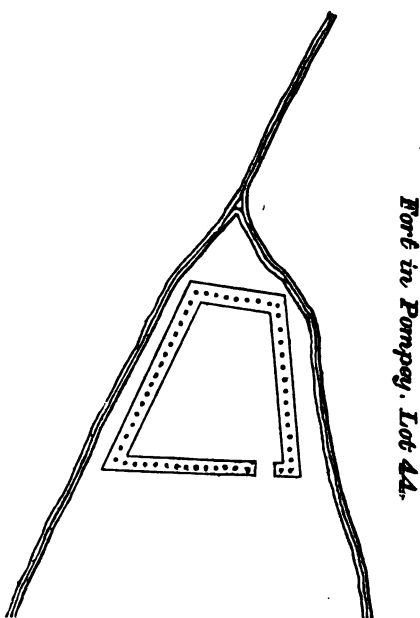


FIG. 9.

47. East of lot 44 was an angular earthwork and stockade, inclosing five acres, with a burial-place. (*Clark.*) The plan given by Clark would seem to be reversed by present indications. This is a prehistoric site, and has yielded very fine articles; among the rest, a clay pipe with 14 human faces, and earthenware with faces luted on at the corners. On lot 68 there is a site of about 3 acres.

48. The site on lot 69 is described by Clark as similar to No. 47, but it is on higher land and has some European relics.

50. On lot 100 is a ditch with a stockade inclosing 8 acres, with raves

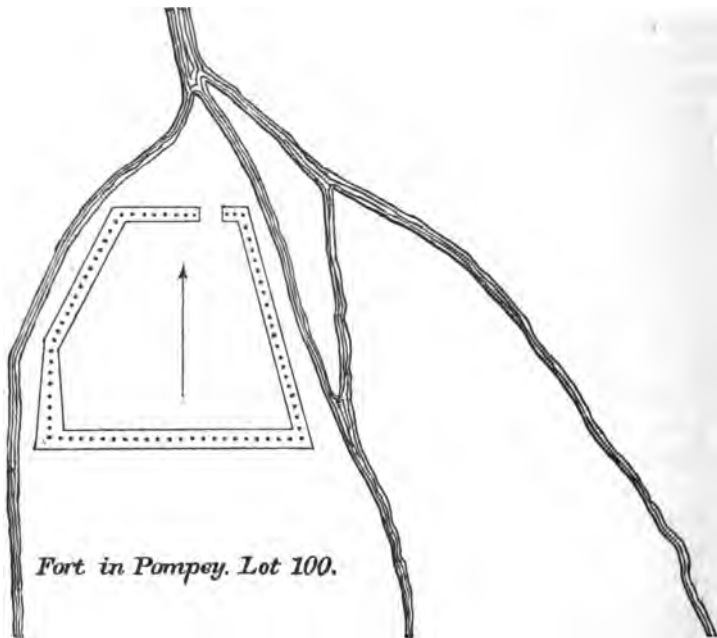


FIG. 10.

within and without. The bodies were placed in rows, which face the east and west alternately. (*Clark.*) A historic site, judged by relics. The post-holes and graves can yet be seen.

49. On lot 99, and like the last (*Clark*), graves are yet distinct.

On lot 98, touching the town line of Fabius, is another circular site on a hill-top, and of early date, though the writer discovered European articles mixed with the peculiar pottery. This is not mentioned by Clark.

54. This was "Indian Fort." An earthwork on lot 33, inclosing ten acres, with a straight ditch across the point, the flanks being defended by steep banks of the ravine. Pottery and early Indian relics abound, but with some European articles. (*Clark.*) Some have supposed this was occupied by the Onondagas just before they moved to Indian Hill. Through this town and on the Seneca and Oswego Rivers brass and iron arrow-heads are sometimes found, of European origin, occasionally perforated, and of the same pattern as those found with the "Skeletons in Armor" at Fall River.

*Town of Manlius.*—The deep spring on lot 79 was the eastern door of the Onondagas, and shows signs of their occupancy. It was the starting-point for surveys. There is a reputed earthwork in the west part of this town, but of doubtful character.

## GENERAL REMARKS.

Some banner-stones of striped slate have been found in Camillus, and one on Skaneateles Lake. Arrow and spear heads are occasionally found in all parts of the country.

The settlements in Southeastern Onondaga show a large and general intercourse with the whites; those in the northern part but very little, the only indications there being the Indian orchards, a few brass kettles at Jack's Rifts, and a few glass beads at Baldwinsville. Many sites have no signs of vessels of any kind. Potstone vessels occur in several localities, but seldom in connection with earthenware. Banner-stones, bird totems, and gorgets of striped slate occur in many places, some apparently recent. Catlinite is found at Phoenix and Onondaga Lake. Polished slate arrows are found on all the rivers, but sparingly. Stone tubes are generally of striped slate, and of many forms, while pipes have their usual variety of form and material. Copper articles are not common, but are generally fine. Stone cups take many shapes, a handsome circular one of striped slate from Hannibal being the finest. Banner-stone and gorgets vary greatly in form and material. Plummets are often highly finished, and some of the finest drills have been discovered here. Arrows and spears are of all materials and finish. Sinkers and hammer-stones occur on most sites, and the latter exhibit a perplexing variety of forms. Many fine articles have been found on the great trail from the north crossing at Brewertown, and others near the east and west trails.

The Onondagas were partial to stockades, although they also had earthworks. None of the settlements seem very ancient, and the defensive works may be placed in four groups: Earthworks along the Seneca and Oswego Rivers, east and north of Baldwinsville; simple stockades about Baldwinsville; earthworks in Elbridge; earthworks and stockades combined in Pompey. The last two groups have features in common, but the others are distinct; they seem of different periods.

The pottery is of the ordinary Indian type, and some attempt has been made to compare sites by its styles of ornament. Celts are of both hard and soft stone, and pestles and mortars of common forms. Semi-circular slate knives are sometimes found, generally without a thickened back.

There are no large burial-places known near the Seneca River, but the bodies found are in a sitting posture, and corn frequently occurs in graves. Horn implements are found on the southern sites, seldom on the northern; and there are marked differences in arrows, spears, and earthenware.

## A PERFORATED TABLET OF STONE FROM NEW YORK.

BY WILLIAM WALLACE TOOKER, *Sag Harbor, N. Y.*

In every considerable collection of aboriginal antiquities can be seen those thin, perforated tablets of stone, commonly called gorgets, twine-twisters, pendants, or whatever else the theory or fancy of different writers or collectors have bestowed upon them.\*

These fanciful titles are mostly conjectures, for it is a recognized fact that no one yet knows the aboriginal use of these tablets with any degree of certainty.† Those with one to five perforations are all given the same name or put into the same class, without regard to the fact that those with more than two perforations of a recognized form were used for a different purpose and should be classed differently.

We do not call drills arrow-points, nor grooved axes celts, because they have the same kind of points or blades.

So it ought to be with the different forms of these perforated tablets. To those with one perforation perhaps belong the name of pendant, having been used for personal adornment, but as the greater number of those with two perforations bear no marks of having been worn suspended by a string, may be called twine-twisters or anything else that theory may invent but cannot prove. As the writer of this brief article does not care at present to theorize in regard to the uses of the tablets with one or two perforations we will leave those out of the subject and proceed to explain the object of this essay.

The tablets with four perforations similar to one already figured and described as a gorget by a well-known writer on this subject,‡ (who does not say whether the specimen bears any cord marks or not, probably not,) belong to another class, and were no doubt used for an entirely different purpose.

It is one of these tablets in my possession that I intend to describe and to prove, as I have already done to the satisfaction of all who have seen it, that it is neither a gorget, twine-twister, totem, or pendant, but something that I have never seen mentioned in any work bearing on the subject that has been accessible to me.

That something is nothing more nor less than a puzzle, a plaything made to amuse some young savage, or perhaps an older one, as we know they are easily amused.

This tablet, of which figures 1 and 2 show the obverse and reverse, is made of slate with the usual countersunk perforations common to all perforated tablets, and is marked on its edge with twenty-four tally or record marks. These have become nearly obliterated by time and weather. This tablet was found on Montauk Point, New York, and must have been

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\* Jones. Antiquities of the Southern Indians.

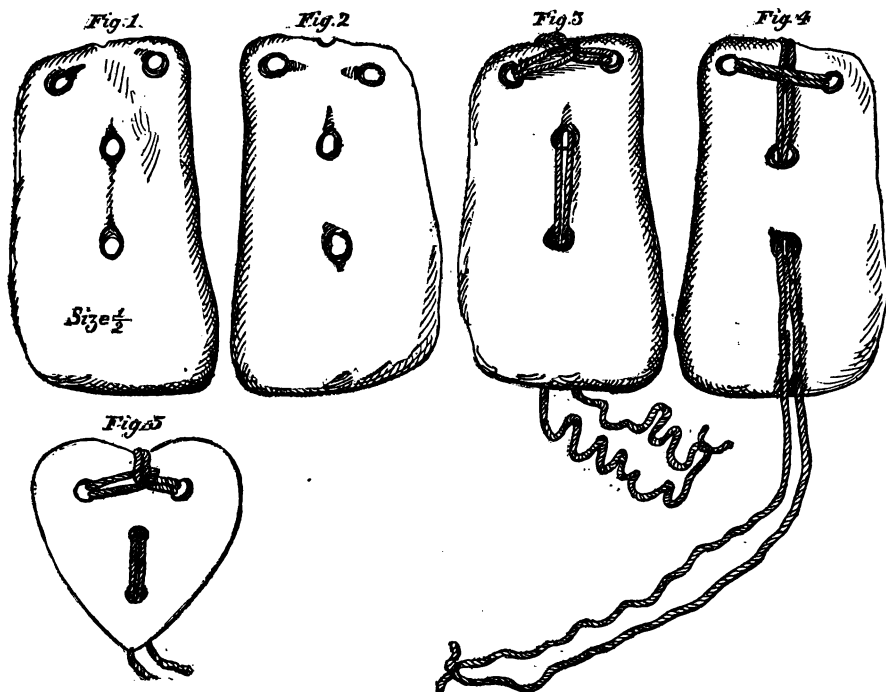
† Rau. Smithsonian Contributions, No. 287, 1876, page 33.

‡ Abbott. Primitive Industry, Fig. 361, 1881.

in use for a long time to have caused the wear near the perforations, consequently have been the cherished property of its aboriginal owner.

One can easily see the marks of where the cords have worn slight grooves or abrasions between the different perforations. This is where it differs from all the tablets with two perforations only that have come under my observation, as they as a rule never bear any marks of cords.\*

This tablet, it will be noticed, bears on its upper margin a slight notch or groove, worn smooth as by the wearing of a cord. The abrasions on this tablet having been made by cords or sinews passing through the



various perforations, the question naturally arises how were the cords put on to have caused the wear in those particular places, and why were they put on in that way? If it was a gorget or a pendant, why the necessity of so much cord traveling through the different perforations, which evidently belonged to it when in use; why so many perforations, when one loop and one perforation would have answered? This I consider as a proof it was not a gorget, nor was it worn as an ornament.

Let me proceed and illustrate as simply as I can how this tablet was used and strung during the aboriginal era. Take a piece of cord thirty-six inches long or thereabouts, tie the two ends together, place it on



were found in good preservation, the remains of a gun barrel and lock, a number of glass bottles, one of which was found nearly half filled with some sort of liquid. These articles were probably obtained from the Dutch, either by present or by trade. There was also found a pair of shears, a pistol, lead pipes, strings of wampum, small brass rings, glass beads; a female skeleton with a brass comb; the hair was in a state of preservation wherever it came in contact with the comb. After the Podunks had removed from these parts they were known to have brought a dead child from toward Norwich and interred it in this burying place."

The Podunk Indians were of peaceable disposition, and we have no records of serious feuds between them and the white settlers. They (the Indians) suffered much from forays of the Mohawks, who roamed across the wilderness from the northwest.

Of scattered relics, quartz and flint arrow points are most frequently found here. These were probably in numerous instances lost by the Indians in hunting. Then we have stone axes, hoes, chisels, gouges, and pestles. A large proportion of the axes, hoes, chisels, gouges, and pestles are made of trap-rock, and many of them have had but very little artificial fashioning to adapt them to their uses.

There are localities in this State, one of which in New Britain, I have particularly examined, where trap-rock, broken from the face of a cliff by the atmospheric vicissitudes of centuries, has accumulated in a sloping pile at the foot of the cliff. This *débris* consists of elongated and angular fragments, some of which, untouched as they are by art, would, if found in our fields to-day, be mistaken for genuine Indian relics. Kettles excavated from lumps of soapstone are sometimes found. These are usually broken and portions missing. They are of rude oval form, with a capacity of from one to three gallons; they have short, projecting handles or lugs at the ends, and are without ornamental carving. The sides and bottoms are from half an inch to an inch in thickness, and are sometimes externally sooted, indicating that they were used in cooking.

Fragments of clay pottery are frequently found here, though it is rare to find a single piece large enough to show the size or shape of the vessel from which it was broken. Occasionally a sufficient number of pieces of one utensil are obtainable to admit of a reconstruction. One which I have in my possession was put together with glue and brick-dust, and some gaps were supplied with the same composition. It is now sound, strong, and perfect in appearance, and, for exhibition purposes, as good as if it had never been broken. This pot is egg-shaped, about fourteen and a half inches high and eleven inches in diameter, with a contraction in the rim below the mouth. The sides are about three-eighths of an inch thick. Similar pottery is always rudely ornamented on the outside by dots or lines, smooth or serrated, which were impressed by pointed implements when the clay was soft. Granules of quartz or mica

were commonly mingled with the clay to prevent cracks in drying; and the ware was finished, without glaze, by burning in the same manner as modern bricks. In fact, it may be regarded as in substance soft brick of poor quality. One of these pots, recently obtained by Dr. Wood, was found in the bank of Connecticut River, in Massachusetts.\* It was much broken, and has been clumsily reconstructed, but is nearly entire. The bottom is quite sharply conical, and the neck has no contraction, but slopes inward quite uniformly to the brim. The figure is somewhat that of a gigantic beet. Now, if we had given us a strap of leather, say 2 inches wide and 18 inches long, and were required to fasten it as a bail to this kettle, an obvious method would be to punch several small holes in the strap near its ends, and drill corresponding holes in the opposite sides of the neck and brim of the kettle and lace the strap thereto with a couple of strings. Whether this particular kettle ever had such a bail we cannot know, but there are the holes of suitable size and arrangement for the purpose. When I first saw them they struck me as an experimental attempt of the finder to sew or lace the broken parts together; but closer examination satisfied me that they had been drilled before the pot was baked, and while the clay was soft, with some tool like an arrow point. Subsequently I learned that the finder testified that the holes were in the sides of the neck when the kettle was found. There are no other drilled holes in the kettle besides these on opposite sides of the neck.

Breaks in Indian pottery sometimes seem to follow lines originally unsound, which gives a hint that the process of manufacture was not continuous, but that successive portions of the work were built up after previous ones had become firm by drying, from which there sometimes resulted an imperfect union between the wet clay and the dry.

About the year 1840 students of the Theological Institute, then located at East Windsor Hill, found on the bank of Connecticut River, at the west end of the institute grounds, a deposit of Indian relics. The place was a sandy knoll, above the highest water-mark of floods, and was traditionally known as "Gun's Hill," and as the site of an Indian fort. The articles then dug up consisted of fragments of large soapstone kettles, of the form previously described, axes, chisels, gouges, arrow-points, and other relics of stone. Referring to the Smithsonian work, No. 287, by Dr. Rau,† there was an article identical with figure 210; the only specimen of its kind that I have known to be found in this region. These relics were scattered among those who found them, and the sand hill has since been cut into by the river, beyond the place where they were found. I have, from that locality, a cup of soapstone that will hold about a pint; and an ancient musket bullet of large size. I have a copper chisel, like Fig. 226; length, 3 inches; width, 2; thickness,  $\frac{3}{4}$ ;

\* West side, midway between Thompsonville and Springfield.

† "The Archæological collection of the U. S. National Museum."—*Smithsonian Contributions*, vol. xxii.

which was found by a laborer in the meadow directly west of my residence. I have not known of any similar relic found in this región.

I have several times visited the locality where was found that remarkable ancient implement of wood, which I described in the Smithsonian Report for 1876, p. 445. It lies so low that it is usually covered by the water of the river. I had a good view of it last September, but made no discoveries, and found nothing to modify the inferences set forth in the report. Undoubtedly the place was an ancient swamp, lower than the present average water level of Connecticut River. The soil was very wet with springs, some of them issuing from holes an inch in diameter. In seasons of low water many springs appear along the banks, most of which are ephemeral. The banks being previously filled with water, partly from the river and partly from the accumulations of rain, drain off in a low time.

A great deal of fine quicksand was issuing from the springs above mentioned, and I found more of this minute sand in the clay than I detected when it was in a frozen state. The natural color of the bed where untinged by vegetable material is very blue—quite different from the browns of the loam and sand now deposited by the river. The grooved log described in the report was unchanged. It inclines downward, as it enters the bank near the low-water line, and lies very firmly in place. Prying upon it with a lever ten or twelve feet long did not change its set in the least. I was deterred from attempting to dig it out by the certainty that the hole would immediately fill with water.

I visited the place again on the 18th of this month. The water was low, and appearances were not much changed. I traced the blue clay formation thirty or forty rods farther north than I had previously discovered it, and found it there containing much less vegetable material. Walking about twenty rods south of where I found the mallet, and near the water's edge, on a gently sloping beach of loamy sand, I noticed a portion of a buried stone, about two inches in length and half an inch in width. The pecked and rubbed surface looked familiar, and on being taken out it proved to be a pestle of gneiss  $11\frac{1}{2}$  inches long and 2 inches in diameter. It is round and smooth, well made, and perfect, with the exception of a small piece broken from the handle end.

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## SHELL HEAPS IN BARNSTABLE COUNTY, MASSACHUSETTS.

BY DANIEL WING, of *South Yarmouth, Mass.*

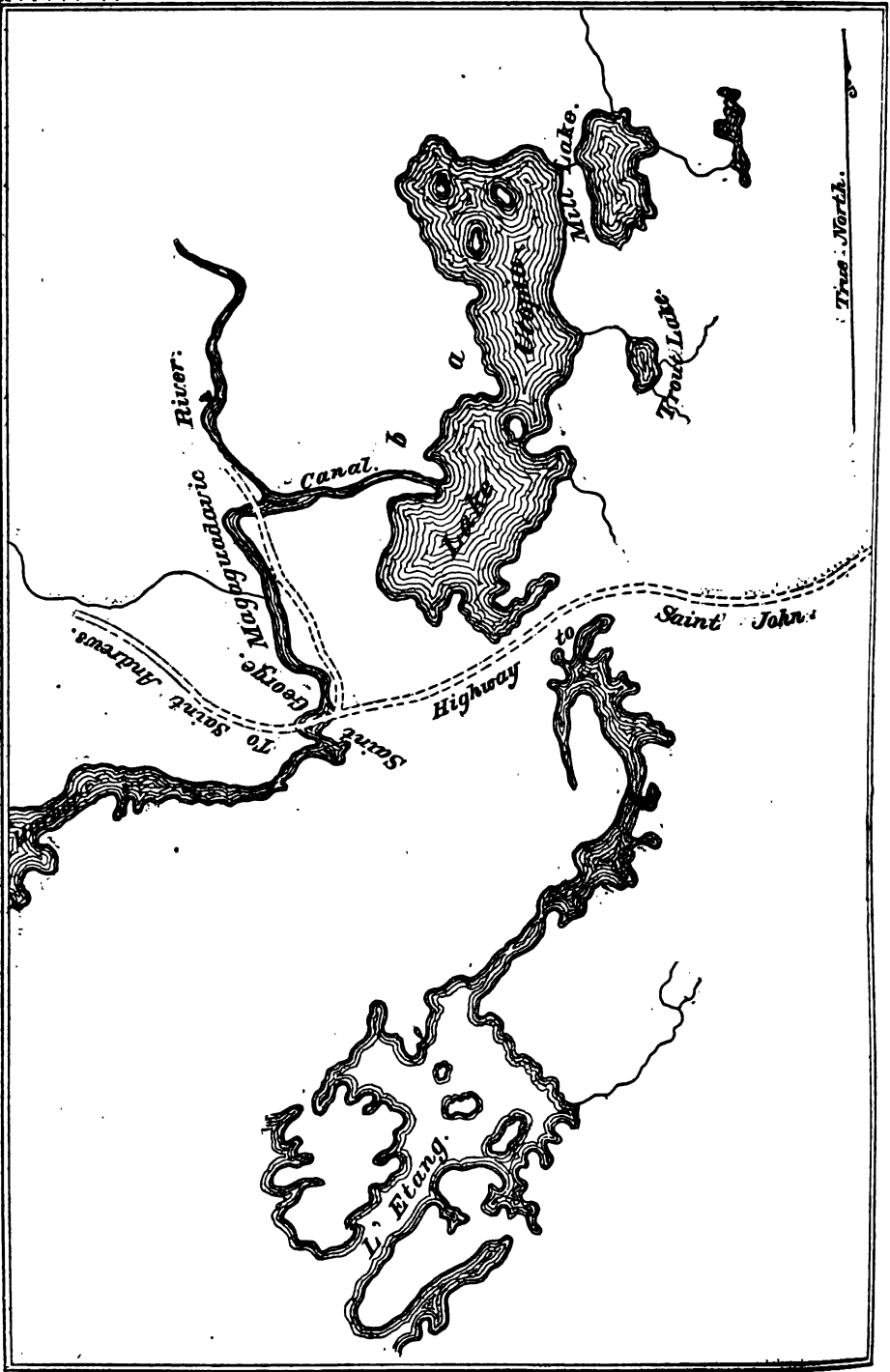
On both banks of Bass River, which separate the towns of Yarmouth and Dennis, in Barnstable County, Massachusetts, are ancient shell heaps and stone hearths. They are particularly numerous in the vicinity of the Old Colony Railroad bridge and below the village of Georgetown; in both cases upon the Yarmouth side of the river. They are

generally upon the brow of the river bank in a commanding position, though sometimes on lower ground. In diameter they vary from 4 or 5 to 15 feet, and in depth from 2 or 3 inches to 2 or more feet. They consist principally of oyster, clam, and quahaug shells. Stone implements have been found in the vicinity of shell heaps in great numbers, though not of many species. This I attribute to the fact that the Indians living hereabout used shells for many purposes. The Pilgrims on landing upon our shores found in the wigwams baskets formed by sewing together shells of the horseshoe crab. I have a collection of nearly a hundred spear and arrow points of stone, in about every form represented in Schoolcraft's large work on the Indian tribes of the United States. I have also a stone pestle, ax, hatchet, and a fragment of a stone mortar or kettle. All up and down the peninsula of Cape Cod are to be found stone implements of the kinds mentioned above—though in the attack upon the Pilgrims at Namskaket Creek, in 1620, the arrows used by the Indians were tipped with brass, eagles' claws, and bits of horn. This last fact led some writers to suppose that the Indians could find no suitable material on the cape for constructing their implements. Though there are no outcropping ledges on the cape, yet there are many boulders and fragments of rock which the Indians found suited to their purposes. I know of several ancient burial places, but they have not been examined, or, if they have, I am not aware of the fact.

### A SCULPTURED STONE FOUND IN ST. GEORGE, NEW BRUNSWICK.

BY J. ALLEN JACK, of *St. John, N. B.*

In the autumn of 1863 or winter of 1864, a remarkable sculptured stone, representing a human face and head in profile, was discovered in the neighborhood of St. George, a village in Charlotte County, in the province of New Brunswick, Canada. This curiosity was found by a man who was searching for stone for building purposes, and was lying about 100 feet from the shore of Lake Utopia, under a bluff of the same formation as the material on which the head is sculptured, which abounds in the neighborhood. This bluff is situated three miles or more from St. George, and Lake Utopia empties into the Magaguadavic River, or, as it may be translated from Indian into English, the River of Hills, which flows towards and pours through the village in the form of a beautiful waterfall. The stone, irrespective of the cutting, which is in relief, has a flat surface, and is of the uniform thickness of 2 inches. Its form is rounded elliptical, and it measures  $21\frac{1}{2}$  inches longitudinally and  $18\frac{1}{2}$  inches across the shorter diameter. The stone is granulite, being distinguished from granite proper by the absence of mica. The sculpture, shortly after it was discovered, attracted a good deal of attention,



and was examined by a number of persons possessing respectable scientific attainments. As far as I am aware, however, neither its visible characteristics, nor its history, or its historical associations have ever been carefully studied by any conversant with American archæology. This carved stone was found at the point marked *a* in the accompanying map. For myself, while undertaking to comment upon this interesting memento of a past age, I must at the outset acknowledge my want of qualifications for the purpose, and explain that my object is rather to suggest than to dogmatize, and to give such small assistance to the learned as is comprised in scraps of information which I have been able to obtain from various sources.

A tolerable knowledge of the history of Charlotte County and of the province, and an imperfect memory and record of the contents of several letters received from various persons upon the principal subject, are all of some service in furthering my purpose. The letters which were written to assist me in preparing a paper upon the stone, subsequently read before the Natural History Society of New Brunswick, an association not now in existence, were unfortunately destroyed in the great fire of St. John. The paper itself was preserved, and embodies at least a portion of the contents of the letter. Opinion, at the time of discovery, was somewhat divided, both in regard to the nation-

ality of the workman by whom the stone was carved and also in respect to the object of the work. Three suggestions, one of which is probably correct, were offered by different parties with reference to the workmen: First, that he was a British colonist; secondly, that he was a Frenchman, and, thirdly, that he was an Indian. The discussion of these several propositions naturally suggests, if it does not necessarily involve, in each case a consideration of the motives of the work-



man. I have little hesitation in dismissing, as highly improbable, the hypothesis that the artist was a British colonist. The appearance and position of the stone when discovered, to which I shall presently

more particularly refer, convince me that it was not carved for the purpose of deceiving scientific investigators, as might be, and I believe has been, charged. For the same reasons I am led to form a strong opinion that the carving was executed long before the date of British occupation. Irrespective of these reasons, however, I would point to the carving itself as an answer to the theory; and the argument here makes as strongly against the suggestion of French origin as it does against that of British. The features and expression of the face are not in any respect European, neither is the shape of the head. Again the elliptical eye, appearing on a profile as it should only properly appear to the spectator in the full face, is a characteristic of Eastern, especially of Egyptian, art. I have not the means at hand to verify the opinion, but, if my memory serves me rightly, this same peculiarity appears in delineations of human faces among the ancient Mexican Indians, if not among other American tribes. The theory for which I contend is, that a European workman, either skilled or unskilled, would have produced something having a semblance to a European subject or work of art. The suggestion of French origin for the sculpture leads me to speak of the connection of the French with the history of this part of the province.

The earliest record of the French occupation of Acadia is that of De Monts, who with a party of fellow-countrymen passed the winter of 1604 on the island of St. Croix, situated on the river of the same name, forming the boundary between the province and the State of Maine, and distant about twenty-one miles from the village of St. George. I have never heard of there being any considerable number of French settlers in the neighborhood of St. George, and cannot even say with certainty that there were any French families permanently settled there. L'Etang approaches to within 300 feet or so of Utopia, and La Tête Passage is distant about eight miles from the village, and the occurrence of these names may lead to the inference that there was a partial French occupation of the adjacent country. I have indeed heard of inscriptions on the rock at Black's Harbor, or its vicinity, on Bliss's Island, which are supposed to be in French, but have never met any one who had actually seen these inscriptions. This island is nearly half way between Campobello or Deer Island and Utopia, from which it is about ten miles distant, and opposite the mouth of La Tête Passage. By no hypothesis, however, am I able to connect this curiosity with any European custom or idea, and consequently the remainder of my investigation will be devoted to the argument in favor of its Indian origin.

If it is possible to derive approximately accurate information as to the age of the stone from its situation and condition when found, it would of course assist materially in discovering the nationality of the workman. I believe that the finder, who, as I have stated, was searching for stone for building purposes, was attracted by the shape of the stone in question; that it was lying on the surface and covered with

moss, and that it was not until the removal of the moss that the true character of the object appeared. An examination of its surface must, I think, convince the observer that the stone has been subjected to the long-continued action of water, and from its situation it seems fairly certain that the water which has produced the wasted appearance was rain, and rain only. An expert might perhaps form a tolerably accurate opinion as to the period which would be required for ordinary rain-falls to effect such results as are here plainly visible. For myself, I hesitate to speak of the precise period where the stone showed no marks of rain. I feel, however, that I am safe in expressing the belief that it would require a length of time commencing at a date before a Frenchman is known to have set foot in the country to produce from the action of rain so worn a surface as this stone exhibits. If this proposition is correct, there can be no reasonable ground to doubt that the carving is the work of an Indian. I may refer, but solely for the purpose of expressing my disbelief in any such hypothesis, to the suggestion that art, employed for the purpose of deceiving, and not any force of nature, has produced the worn appearance to which reference has been made. The mossy deposit, and the unfrequented locality in which the curiosity was found, both aid in dispelling this idea; but even had it been found in an often visited part, and without its mossy covering, I should have no hesitation in affirming that its worn appearance was not due to the hand of man. I may further urge that, had the object of the workman been solely to deceive, he would have scarcely selected a stone whereon to carve of a granite character, and especially a piece of granulite, one of the hardest of rocks to work, being not only hard in quality but of crystalline structure, and ill-adapted for receiving a polish, at least under rough tools. Granting, however, that for the reason stated we are justified in assigning the origin of the carving to the Indian period, there still remain many difficulties in the way of determining its object or meaning. There are at the present time several Indians in the neighborhood of St. George, but half a century ago there were many more in that locality, and previous to the commencement of that period the vicinity of the canal, about one and one-half miles from the bluff mentioned before, was continuously a favorite camping ground for these people. The Magaguadavic Lakes abound in fish, even at the present day, and the surrounding woods, formerly well stocked with all kinds of game, would prove a great attraction to the savage hunters, and the proximity of the sea would also add to the attractions. The Magaguadavic Indians speak the Micicete language, and are, I believe, members of that tribe, and are, of course, descended from the Algonquins. I speak with some hesitation of their being Micicetes, because I understand that the Passamaquods claim to be distinct from the Micicetes, and there may be some question whether Magaguadavic Indians were not a portion of the former tribe. A very obvious question presents itself to the mind of the investigator, which may here very properly be considered. What purpose would an Indian have in view in producing this curious



work of art? In the paper which I read before the New Brunswick Society I was unable to give any tolerably satisfactory reply to this. At the present time I think that I can suggest an answer which may be correct, and which, at least, deserves some consideration. The members of that society were, if I mistake not, generally impressed with the force of the arguments brought forward to support the suggestion that the sculptor was an Indian, and were inclined to guess that the carving was, in some indefinite way, connected with the funeral rites, or was in commemoration of a departed brave. No work published at that time afforded any solution of the difficulty. No relics of a similar character to this had been dug up at any Indian burial ground in New Brunswick, and although our Indians produce very well executed full relief figures of the beaver, the muskrat, and the otter, upon soapstone pipes, their skill apparently goes no further in this direction. I have indeed seen rude sketches of human figures executed by these people, but have never seen or been informed of any likeness to a man being carved by them in stone. It was only by bringing pieces of information together, and after the lapse of some years, that I was enabled to suggest an answer to an apparently almost unanswerable question. Upon one occasion, while in conversation with an old resident of St. George, he gave me an account of a somewhat singular monument which, many years before this period, stood on the summit of a high hill near the canal, and about one-half mile distant from the place where the carved stone was found. It consisted of a large oval or rounded stone, weighing, as my informant roughly estimates, seventy-five hundred weight, lying on three vertical stone columns, from ten inches to one foot in height, and firmly sunk in the ground thus . . . (The above weight, I should imagine, is an over-estimate, but I give it as stated to me.) The site of this monument is marked *b* on the preceding map. My informant stated that the boys and other visitors were in the habit of throwing stones at the columns, and that eventually the monument was tumbled over, by the combined effort of a number of ship carpenters, and fell crashing into the valley. Some years afterwards I read, for the first time, Francis Parkman's "*Pioneers of France in the New World*," when my attention was at once arrested, and the conversation with the gentleman from St. George brought to my mind, by a passage which occurs on page 349, of that highly interesting work.

Champlain, the writer states, had journeyed up the Ottawa River beyond Lake Coulanges, and had reached an island in the neighborhood of the village of a chief named Tessonat, which, Mr. Parkman is of opinion, was on the Lower Lake des Allumettes. I quote what the historian writes of what the French explorer sees: "Here, too, was a cemetery, which excited the wonder of Champlain, for the dead were better cared for than the living. Over each grave a flat tablet of wood was supported on posts, and at one end stood an upright tablet, carved with an intended representation of the features of the deceased."

Now, it may be that there is no connection whatever between the Indian custom described by Champlain, as existing at the place described, and the finding of the sculpture and the appearance of a large stone, supported on stone columns, at a place in New Brunswick. The points are certainly far apart, and while in the one case there is clear evidence of the common custom, there is in the other barely sufficient evidence to justify the supposition that there may be a single instance of the adoption of the custom. The Magaguadavic Indians indeed have a tradition that they were driven from some distant part of Canada to the seaboard, but if this were established as a fact, it would scarcely aid in the elucidation of this matter. Two conjectures may be made, however, either of which if correct might account for the supposed existence of an Ottawa custom in New Brunswick. An Indian might have been captured, or might have been expelled by his brethren on the Lower Lake des Allumettes, and been carried, or have found his way, to the maritime province. Or, a young Milicetes might have been carried away by the Ottawas, and have escaped to his old home. In the one case the prisoner would naturally wish to secure for his burial place the monuments which had ornamented the graves of his fathers, and might have succeeded in securing the aid of his captors in the accomplishment of his object. In the other the escaped captive might well desire to adopt the arts of his former masters, and wish to take his last rest beneath a monument with his effigy at its head. The use of a large stone instead of a wooden tablet scarcely deserves comment, for the change of material would in no sense interfere with the object in view, but on the contrary would render the monument more deserving of the name.

I think that a careful or even superficial examination of the carving must impress the observer with the idea that it is intended to represent the face of an Indian, and the head, although viewed only laterally, certainly presents many of the peculiarities of the North American type. Of course the examiner is placed at a great disadvantage in having only a profile, and not a completely developed head, as for ethnological purposes craniology is chiefly available when an opportunity is given to measure the comparative breadth from the petrous portion of the right, to the petrous portion of the left temporal bone, or to measure from and to the parts of a carved head representing these portions. There is a portrait of a Magaguadavic Indian by Mr. C. Ward, of St. George, which is considered to present some points of resemblance to the head in discussion, which may be found in the Illustrated London News of the 5th of September, 1863, No. 1220. The fashion of wearing the hair as represented by the carving is perhaps somewhat calculated to puzzle the investigator, but there is scarcely anything sufficiently definite in the delineation to enable one to trace an analogy to either Indian or European fashions. It may be noticed that some have expressed an opinion that a wig was intended to be represented.

## A SUPPOSED SPECIMEN OF ABORIGINAL ART,

Discovered at Gondola Point, parish of Rothesay, in Kings County, New Brunswick, and exhibited at the Provincial Exhibition held at the Mechanics' Institute, St. John, New Brunswick. (Autumn of A. D. 1851?)

BY G. F. MATTHEW.

Living in the neighborhood of the spot where this object was found, I undertook, at the request of J. Allen Jack, esq., to make inquiry into the circumstances connected with its discovery. It had been found, I was told, on the farm of Andrew Kilpatrick (now owned by David Kilpatrick), about half a mile from the Episcopal church, near Gondola Point. It was turned out from a depth of between three and four feet below the surface of the ground in digging a cellar on the farm referred to; and was intrusted to Mr. Harding to take to St. John and exhibit at the provincial exhibition held at the Mechanics' Institute (in the year 1851?)

In general outline the object, which is a rough-looking stone, is of an



oval form, 2 feet 11½ inches long, 1 foot 3½ inches broad, and 1 foot 2½ inches deep; and as regards most of its surface does not differ from an ordinary bowl-

der of Lower Carboniferous conglomerate, numbers of which lie scattered around the neighboring fields. This conglomerate consists chiefly of pieces of granite, and protogene in association with less numerous, but characteristic fragments of crystalline limestone of the upper series of the Laurentian area, the border of which lies about a mile to the southward of the point where the boulder was found. I am satisfied, therefore, that the boulder was not brought from a distance, but belongs in the neighborhood where it was dug up.

While, as regards most of its surface, this stone does not differ from an ordinary boulder, there is an exception in the appearance of one end. This has been carved into the form of a human head, looking out, as it were, from the end of the stone. The features are aquiline, rudely carved, and somewhat irregular, as though chiseled by an unskilled hand. They present the appearance of having been worked out upon the surface of the stone by using certain hard protuberances as the basis for the more prominent features and graving the rest to correspond. The artist has apparently seized upon a rude semblance of the human face presented, and worked out the finer lineaments to correspond.

On examining the carved head carefully it was found that the surface had been coated with a dark-red pigment. This could hardly have been on the stone when it was dug up, if, as I was assured, it came from a depth beneath the surface of three feet or more; and for the following reasons I suppose it to have been painted after it was exhumed.

An examination of the bank or hillside where the relic was found revealed the presence of "Drift," a deposit of the glacial and post-glacial period, immediately below the surface loam, which is a foot thick. The point at which the stone was dug up is not more than about sixty feet above the Kennebecasis River, and it would thus for a long period have been below the sea-level in the time marked by the accumulation of the Ledalelay of which (or of the boulder clay) the deposit containing the stone lay consisted. If buried by natural causes in this deposit the age of the relic would be carried back to a very distant period—a period so distant that one may question whether it could have had its present appearance at that time. And it seems more reasonable to suppose that if it possessed its present aspect when dug up, it must have been buried later than the Drift period, either by accident or design. The paint with which the face is covered appears to have been a subsequent embellishment, for long-continued exposure to the action of the elements would have removed the oil or other substance which serves to give body to the color, and the paint would have remained as a dry powder liable to be brushed off with the slightest touch.

The mode of burial of this stone cannot now be verified, owing to the crumbling condition of the bank, and its actual age as a work of art must remain to a great extent a matter of conjecture. The naturally rough features have been rechiseled, and (since the stone was dug up) coated with paint; so that in some respects the object is not in its pristine condition, and its value as an object or specimen of aboriginal art has been seriously marred by these changes.

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## ANTIQUITIES OF NOVA SCOTIA.

BY REV. GEORGE PATTERSON, D. D., of *New Glasgow, N. S.*

No earthworks, properly speaking, exist in this region, but shell heaps are to be found in various places. The shores of this county at various places give evidence of the former occupation of the country by the aborigines, particularly the shells, which are found in the soil as it is turned up by the plow, and the stone implements which were formerly picked up in abundance, and are still sometimes found, though more rarely. The principal places are, Middle River Point, Fraser's Point, both sides of the East River at its entrance into the harbor, Fisher's Grant, and the Beaches, all in Pictou Harbor, and almost every island

and headland in Miegomish Harbor. In the neighboring counties on the northern shore of the province, the same thing is to be found, particularly at Antigomish Harbor to the east, and at Tatamagouche to the west.

There is scarcely anything in this province that can be called a mound or earthwork, at all events like those found in the Western States. There was found some years ago, at Tatamagouche, a small heap. It was situated on the farm of the late Rev. Hugh Ross, next to A. Campbell's, which forms Campbell's Point, at the entrance of the harbor. It was opened and examined some fifty years ago by the late Dr. Thomas McCulloch, of Pictou, who found in it a large number of human bones, and various stone implements. He published no account of them, but I have learned that he came to the conclusion that it was a place where a large number had been buried, probably after a battle. The spot has long been plowed over, and the ground leveled.

There was another found at Kempt, Yarmouth County, in the western part of the province. The spot where it was found was some fifteen miles in the interior, and some distance from the river. It was opened by Dr. Joseph Bond, of Bear River, Digby County, N. S., and from him I learned that it was about ten feet in length, five feet in width, and four feet in height. It has been represented to me as resembling a large cradle hill. In this were found forty very beautifully executed stone-arrow or spear-heads, which are now in the county museum at Yarmouth, established by L. E. Baker, esq., who has had them photographed. Dr. Bond supposed that it was an ancient burying place, though he found no bones, for which he accounted by supposing that they had become so entirely decayed as to be no longer recognizable. But Dr. John W. Webster, of Yarmouth, informed me that from the material around he believed it had been the site of an old workshop. This might be the case, and the mound might have been a *cache* of such implements.

I have seen some thin layers of shell at points on the shores of our harbors, but I am told that there are some of considerable thickness at points in Miegomish Harbor. They are generally close by the shore, and the sea, wearing away the soil, exposes them on the banks. But none in this part of the country have undergone a proper examination.

There are in the museum of the Mechanics' Institute, St. John, N. B., two sculptures. The one is very rude, and will be found figured in Dawson's *Acadian Geology*. The other is a medallion of about fifteen inches in diameter, containing a rather well-executed profile of a human head. But I am not certain that this was found in the province.

The rocks on the north shore of the province are soft, and are being worn away so rapidly that if there had been any carving upon them it would long ere now have disappeared. In Yarmouth a stone has been

found on the shore with what looks like letters engraved on it, but they have never been deciphered. The stone is in the possession of John K. Ryerson, of Yarmouth. Dr. Gilpin, of Halifax, has discovered a rock in Annapolis County with some engraving on it. In the history of the county of Pictou, published by me, on pages 29-31, will be found an account of the only genuine prehistoric cemetery with which I have met. I could see no plan of arrangement in the graves. They would be found at distances of from three to five feet apart, and over a space of about fifty feet square, lying to the west of a pit. I was not able to find any to the eastward, that is, farther away from the shore. The graves formed a layer of brown, velvety mold, two or three inches deep, and containing fragments of bones. The ground is gently sloping and facing southwestwardly. In only one instance could I detect the posture of the body. This one was lying on its side, and doubled up. In other instances there were plainly a number together, and the bones were so decayed and seemingly so mixed, that I could not trace any order. I did not particularly observe, but I think the body lay north and south with the face to the west. The graves were shallow, not more than from nine to twelve inches deep.

There was no evidence of desiccation. But there is in the possession of Dr. Wm. Doherty, of Kingston, Kent County, N. B., a perfect mummy of an Indian head. The face retains its features, and the hair adheres as completely as in life. It was found on a part of a bank of the river Richibenclo. Along with it was found a copper kettle, showing that the burial took place after the arrival of Europeans, and while they still retained the practice of burying the valuables of the deceased with him. The skin has a bluish discoloration, probably from the copper. I am informed that up the St. John's River a large copper kettle was found with the remains of a body, which had been squeezed into it.

There are no quarries. There is an island known in the Micmac language as Pipestone Island, to which they may have resorted for materials for their pipes, but I have not been able to find the place.

The only workshops that I have heard of in these maritime provinces is what is known as Bockman's Beach, Lunenburg County, N. S. It is a beach of sand and gravel, running east and west, perhaps 300 yards in length and connecting an island, known as Bockman's Island, with the main-land. On the north side the sea has heaped up the sand and gravel, but in the rear of this it is lower, and here, about midway between the shores, have been found large quantities of flakes and splinters of stone and arrow-heads in various states of preparation. Many of these have been carried away by collectors, but the sea washes over the spot, and after every storm more are exposed.

A small circular heap, about 6 feet in diameter, and from 15 to 18 inches high at the time of my visit, has been supposed by some to have been the seat of the ancient arrow-maker. But on close examination of the spot and from information received from those living in the

neighborhood, as to the changes effected upon the shore by the action of winds and the sea in storms, I could easily see that the sand around it had been swept away, leaving this spot a little above the head of the surrounding beach. In fact changes have been going on which render it impossible to ascertain how the ground lay in those old days. But the amount of splinters, hammered stones, &c., plainly shows what had been going on. These principally consist of agates and jaspers, which are not to be found in any rocks near, but are similar to those found at the present day in the trap rocks bordering on the Bay of Fundy, forming the northern mountains of King and Annapolis Counties, distant, in a direct line across the country, nearly sixty miles. A few are of the dioritic rocks, which are found intrusive in the southern mountains of the same counties, and some are of quartz, such as is found in the metamorphic rocks in the immediate neighborhood. An examination of these rocks shows the process which had been going on. Here is a stone at which the old arrow-maker had been hammering, with the view of splitting it longitudinally, but the result was several cracks crosswise, and it was thrown away. Here is a disk-like stone, around the edge of which he had been hammering, but, instead of splitting through the center, it broke away in fragments to the side. And then there are flakes of all sizes and thickness. A few complete arrow-heads have been found, and a much larger number of imperfect ones. These are all small, from  $1\frac{3}{4}$  to 2 inches in length, but are very finely executed. Stones are also picked up which bear on their edges the evidence of having been used as hammers. A few stone chisels or axes have also been found, but it is evident that the work carried on was mainly of forming arrow-heads, for which they brought from the Bay of Fundy the finer stones mentioned. Small pieces of copper are also found. They consist sometimes of small nuggets seemingly in their natural state, sometimes they are flattened out by hammering, and they are also formed into small knives or piercers.

There were portages, where they carried their canoes from one lake or stream to another, or across a headland. These were mere paths through the forests, and are now either grown up with wood or have been plowed up.

I have some small copper knives and small specimens of copper, the latter from Lunenburg County. It has commonly been supposed that the Micmacs were entirely ignorant of the use of metals till the arrival of Europeans. These show that they had at least got to the length of making use of the small specimens of native copper found in the trap rocks of the Bay of Fundy. I have also some bone spear-heads, a good deal decayed, from some cemetery; also, a pipe from the same place. It is made out of a very hard granitic rock, and Dr. Dawson, of McGill College, Montreal, our highest authority on the geology of these regions, says that he knows no rock of the same kind nearer than Bay Chaleur,

and, furthermore, he has since received a number of pipe-heads, resembling it in shape, from the Upper Ottawa.

There is, in the Provincial Museum at Halifax, a collection of various aboriginal antiquities. It contains, besides the usual stone axes and arrow-heads, some small pieces of copper, similar to those from Bockman's Beach, and a flat pipe found in the interior of the province, remarkable from the circumstance of its having been found so far east, it being held that this is characteristic of the mound-builders or tribes of the far West. There are also a few articles in the museum of the Mechanics' Institute of St. John, N. B. The most remarkable are the sculptured figure and medallion already referred to, and a small hammer with a short stick for a handle, remarkable for the manner in which it is fastened to the helve, being merely held by a band of burnt clay. Professor Jack, of the University of New Brunswick, Fredericton, N. B., is said to be the best authority in that province on this subject. In the collection of Judge Desbusay, of Lunenburg County, N. S., are also small pieces of copper from Bockman's Beach. Dr. Gray, of Mahone Bay; in the same county, also has a collection.

## THE ABORIGINES OF FLORIDA.

BY S. T. WALKER.

In comparison with their number and size, the shell-heaps of Florida contain but few relics of the people who constructed them. Besides the ashes of their fires, the refuse of their feasts, and the fragments of their utensils, we find but little to aid us in our researches into their civilization or condition. The shell-heaps are so vast in size that it is only when the sea has swept away their slopes or when the lime burner has attacked their sides that we get an insight into the mysteries of their interior, and even then there is little to be obtained and but few uncertain data given upon which to base a calculation. By far the greater mass of these heaps is composed of shells, bones of mammals and birds, ashes, charcoal, and thin layers of soil. Scattered throughout the heap however there are quantities of broken pottery and near the top, a few objects of stone, and numerous implements of bone or shell.

The accompanying diagram represents a section of a shell-heap at Cedar Keys, Fla., formed by cutting through the center of a mound to open a street. This may be considered a fair representation of the interior of all shell-heaps with the exception of the unusually thick stratum of soil near the center of the mass. From this it will be seen that the pottery is pretty uniformly distributed throughout the heap from the bottom to the top and is generally in small fragments, most probably pieces of pots and utensils accidentally broken during the ordinary culinary opera-



tions of their owners. I have never known a whole vessel to be found in a shell-heap. An examination of this pottery, then, it seems would give

## SECTION OF SHELL-HEAP.

Six inches of modern soil.
<p>(Later stage.)</p> <p>Fine thin pottery beautifully ornamented. Neatly-made implements of bone, shell, etc. Axes, arrow and spear heads of stone; also stone-beads and objects of stone used in games.</p> <p>Three feet.</p>
Two feet of soil containing a few fragments of pottery.
<p>(Middle stage.)</p> <p>Better pottery, rudely ornamented. Primitive implements of bone and shell.</p> <p>Four feet.</p>
<p>(Earlier stage.)</p> <p>Rude, heavy pottery, destitute of ornament.</p> <p>Three feet.</p>

us a pretty correct idea of the progress of the aborigines in the art of pottery during a period of time corresponding with that of the age of the shell-heaps. An inquiry therefore into this progress among the builders of the shell-heaps necessarily involves a question of time, and is by far the most difficult part of the subject.

In the section of the shell-heap given in the illustration, it will be seen that a stratum of soil six inches in thickness has accumulated since the completion of the mound, and that a similar stratum nearly two feet in thickness occupies a position near the center of the mass, indicating a cessation in the growth of the heap, when it had reached a height of seven feet, for a period of time sufficient for the accumulation of this two feet of soil on the surface of the shell. After this the accumulation of shell begins again, and when it had acquired a depth of three feet it ceased again and this time forever.

Now, we know pretty well how long a period has elapsed since the aborigines ceased to inhabit this region, and although it is possible that there has been no addition to this heap for seventy-five or one hundred years, we know positively that there has been none for the last fifty years. It requires then at least fifty years to accumulate six inches of soil on a shell-heap, and consequently we may be justified in supposing a period of two hundred years to have been necessary for the formation of the central stratum of soil in this mound.

A comparison of the pottery immediately above and below this stratum of soil representing a period of two hundred years ought to give us some idea of the rate of progression made in the arts. And a critical comparison of the different styles of

pottery with each other in different portions of the heap should give us a rude idea of the age of the shell-heaps. The object of the present

paper is to present the reader with a description of the relics and pottery found in each stratum of the shell-heap, beginning at the foundation and ending at the top, and from a comparison of the various styles which mark the march of progress and improvement, to hazard a conjecture as to the time which elapsed from the beginning of the shell-heaps up to the advent of the European.

In all the large shell-heaps examined hitherto I have invariably found pottery in the lowest stratum of shell, and, in many instances, in the soil beneath the foundations, which I regard as conclusive evidence that the aborigines were acquainted with the art of fabricating earthenware pots long before they began these vast accumulations of shell. The art however was in its rudest state. The fragments are thick, heavy, and coarse, the composing clay often containing a mixture of coarse sand or small pebbles. The utensils were of large size and rudely fashioned, as shown by the curves of the fragments, and they were destitute of all attempt at ornament. The rims were plain, and were not thickened or re-enforced to increase their strength. This style is found generally for about three or four feet in height, and may be said to represent the first stage. Above this a gradual change is perceptible, the two styles overlapping, so that it is difficult to say where one begins and the other ends.

The second stage however as we ascend, soon becomes plainly marked. The walls of the utensils become thinner. The rims are turned outward and slightly thickened. Dots and straight lines are cut into the sides of the vessel by way of ornament, and the thickened rims are sometimes "pinched" like pie-crust with the fingers. During this stage the savage artist first began to mold his wares in rush baskets, which were subsequently burned away, leaving the vessel curiously checked as though it had been pressed while wet with coarse cloth. The use of sand or gravel is totally abandoned during this stage, and the quality of the pottery is in every way improved. Implements of shell and bone are sometimes found, but they are generally few in number and rude in manufacture.

This brings us to a portion of the shell-heap corresponding in position with the two-feet stratum of soil shown in the diagram, and that stratum marks the transition period between the middle and modern styles of Indian pottery. Immediately below this layer of soil we find the curved line introduced in ornamental designs on the utensils, and a few fragments of the rims of pots show that ears began to be attached to them for the convenience of suspension, and that the thickness of the ware was reduced by the employment of better materials. Immediately over the stratum of soil all the fragments show improvement on those below. New patterns are introduced, and we begin to find fragments of dishes, bowls, cups, as well as those of jars and pots, many of them of elegant design and of a superior quality of ware. Stone axes, arrow-heads, bone and shell implements are of frequent occurrence.

As we approach the top, marks of improvement are numerous. All the larger pots are furnished with numerous ears, through which strings might be run for suspension. Vessels are sometimes furnished with handles, and all the finer wares are elaborately ornamented with zigzag lines, curves, dots, and, in rare cases, with figures of men and animals. The finest wares are invariably found on or near the surface, and among them we find the first attempt at coloring their work.

We thus observe that from the testimony of the pottery the age of the shell-heaps is divided into three distinct periods, which may be styled the ancient, the middle, and the modern, which are further divided by two periods of transition, the latter of which is marked by the stratum of soil representing a period of two hundred years. Assuming that the march of improvement was uniform, and seeing that a period of over two hundred years\* was occupied in a transition from the middle period to the modern, I think we might be safe in attributing a period of at least two hundred years to each of the five eras mentioned above. This would give one thousand years for the age of the oldest shell-heaps.

I might properly extend this time much beyond these figures, as there are many shell-heaps which were abandoned fully as long as this upon which there is no accumulation of soil, or at best but little, so it would seem that I have adopted the smallest period of time necessary to a correct calculation, still these calculations may be far from the truth. There are so many possibilities to be encountered that the question of age is lost among them. The growth of a shell-heap depended, of course, upon the number of people living in the vicinity, whether their residence was continuous or occasional, the abundance or scarcity of shell-fish, and many other accidents too numerous to mention. Layers of soil in different portions of the same heap show that portions of the mass ceased to grow for long periods of time, while thick strata of clean shell indicate the rapid and continuous growth of other portions. Future investigations may throw more light on this subject at present involved in doubt and mystery.

The key to the whole matter is a critical study of ancient pottery. That the aborigines of Florida reached the state of advancement in which they were found by the Europeans by slow and painful steps is evident to the most superficial observer. That they did advance is equally plain. According to the estimate of time made in this paper it was three hundred years before they thought of ornamenting moist clay with lines and dots, and five hundred years before they thought of making ears to pots. Dishes and bowls were not thought of for eight hundred years, and cups with handles for nearly one thousand. Still they progressed, and who can say what point their civilization might have reached had the discovery by Columbus been delayed another thousand years?

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\*I say "over two hundred years," because this transition began in the latter years of the middle period and continued in the earlier years of the modern period.

## ABSTRACTS FROM ANTHROPOLOGICAL CORRESPONDENCE.

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Numerous correspondents of the Institution, in writing upon various matters, frequently convey valuable information. It is the design of this chapter to put on record those statements of correspondents respecting archæology that are not sufficiently long to form a separate article.

BARKLEY, W. F., writes that about 15 miles from Mount Pleasant, Pa., are the remains of a burying ground, in which the dead are interred beneath piles of stone.

CAREUTHERS, ARTHUR, writes that in the western part of Amherst Township, Lorain County, Ohio, on the farms of Joseph Rice, David Shevarts, and others, are sandstone rocks rising about 1 foot above the ground and from 6 to 50 feet across the top. They belong to the Waverly sandstone. The impressions of Indian moccasins, bears' tracks, turkey tracks, and those of small birds are very plentiful. They do not all run in the same direction, but cross and recross one another.

COUES, ELLIOTT, mentions a cliff-house on Beaver Creek at its junction with the Rio Verde, 40 miles from Fort Whipple, Ariz.

FERRY, O. M., of Oneida, New York, mentions the opening of a trench of buried Indians. Part of the bodies were in wooden coffins, plainly indicating recent burial. Some of the dead had been wrapped in blankets, and a child's moccasin was ornamented with glass beads. Buttons and bricks also add their testimony to the fact that the cemetery is not ancient.

FLINT, EARL. Rock inscriptions extend all along the summits of the Cordilleras, from Bolivia to Mexico. They are similar in character. At Telembela, in Ecuador, is a sacrificial stone, similar to that in Mexico. A sculpture of a chief with a scepter in each hand, surmounted by a condor, and standing on the prostrate form of a suppliant, was found in Peru. This resembles very much the figure in the Palenque stone, but it is coarser. At Samiapata, near the top of the declivity, sculptured in relief, is a figure of a tiger. A little higher up is a similar one, more massive, from which a double series of rhombs lead from the sculpture to a kind of throne, supported on four feet of a bird of prey, surrounded by a circular line of seats. These all join to form the body of the cross. The top is in shape a species of platform, on which are chiseled hemispheric holes, one yard in diameter, communicating with one another by

small canals. Sculptures of this class occur from Bolivia to Columbia. Lower down, at Samiapata, are niches cut in the rock, and buried near them are inscribed stones. Similar ones, and less elevated, where the Cordilleras separate the territory of Chaco from Chiriquanes, occur in a real desert, and being on a declivity, have escaped the alluvial burial of the first. Inscribed on the stones found at Chaco and Samiapata and those of the niches are the same persons, figures and paintings as those on the murals of Palenque.

GRAHAM, N. B., writes that there is a mound four miles south of England's Point post-office, Cherokee County, North Carolina, on the farm of Jesse Raper. It is the only mound within ten miles, is circular in ground plan, 120 feet in base diameter, and 90 feet apex diameter. It is composed of alternate layers of burnt clay, ashes, and soil.

HARLAN, CALVIN S., describes a cave in a rocky hillside, four miles from Ellora, Baltimore County, Maryland, known as the Old Indian Cave. It extends into the hill about 36 feet. Around the entrance are ashes and charcoal, which are also mingled with the earth about the floor; oyster shells, some of which show the action of fire, occur in the *débris*. Arrow-heads are also reported to have been found.

About one and a half miles from Sweet Air, in the same county, are the remains of an old Indian trail, leading from the Rocks of Deer Creek, in Harford County, a seat of the Susquehannocks, to a settlement south of Sweet Air post-office, at which spot arrow and spear heads have been found, together with several axes.

Other localities in the vicinity of Sweet Air have been mentioned where chipped stone implements occur.

HOMSHER, G. W., Fairfield, Indiana, writes to the Institution that he is preparing maps and sketches of the mounds, circles, implements, &c., of Franklin County, in that State.

KALES, J. W., sends the following report: Along the east shore of Cayuga Lake, New York, occur many relics of aboriginal populations. On the beach are found multitudes of notched sinkers. On the points these relics are most numerous. Several burial places have been discovered; one of them is on a small island opposite the village of Union Springs. The skeletons rest on a substratum of rock, about 2 feet below the surface. A large number of skeletons were unearthed about one mile north of Union Springs and 200 feet from the lake. They were promiscuously buried in a pit under about 2 feet of fine black earth, those of men, women, and children being intermingled. The skeletons of males indicated men of large size and great strength. No relics occurred in the pit.

LUTHER, S. N., writes to the Institution with reference to the former use of manganese as a degreassant in the manufacture of Indian pottery,

in the vicinity of Nelson Ledges, Portage County, Ohio. These ledges are outcrops of the conglomerate, and their cavities had furnished shelter for the ancient people. In the talus and on the higher level are found areas of dark soil, rich in relics of various kinds, and among these only occur the lumps of manganese. This mineral crops out in places at Bainbridge, twenty miles away, and no nearer. Pottery fragments, showing black spots of the manganese, and lumps having a polished surface, have been picked up. Mr. Luther also speaks of a great mortar which appears to have been used in crushing quartz.

MCLEAN, JOHN J., while transmitting a meteorological report from Sitka Castle, Alaska, notes the "fish-dance," performed in honor of the arrival of the shoals of herring. "The herring are so plentiful that an Indian with his nail-studded thin board could catch a canoe full in an hour. The Sitka Indians built fires at the mouth of Indian River, and sang and danced their national airs every night for more than a week. I witnessed several of the dances at the arrival of the fish. None but the men participated, the women sitting around the fire and keeping up a shrill monotonous chorus. The dancing movement consisted in a step from one foot to the other and stamping to emphasize the music, the body more or less stooped, and the head jerked from one side to the other in rapid movement. The melodies were extremely simple, containing three or four notes. The time was now slow and stately, like a funeral dirge, again quick and lively. There were numerous pauses, each ushering a slight modification of the melody and time. On the whole the tune was not inharmonious, having a barbaric fitness to the people and the occasion. They seem to have an appreciation of the picturesque, for they had chosen one of the prettiest spots in the whole neighborhood for their festivities. The dark snow-capped mountain for a back-ground and the broad waters of the beautiful bay, lit up by the full moon. The subject of the songs was a description of hunting and fishing. Their costume consisted of blankets with tin tags, sewn on, jingling with each movement of the body, wigs made of oakum and eagles' feathers, and blackened faces striped with vermilion. The sports were kept up each night until a late hour.

MACLEAN, J. P., describes and figures in his letter of December 10th two circular inclosures in Sycamore Township, Hamilton County, Ohio.

He also found on Blennerhasset Island numerous antiquities, among them a shell heap, 100 feet long. He reports that Dr. G. O. Hildreth, in sinking a cistern a little west of the Graded Way, Marietta, Ohio, came upon a cave containing human and animal bones. The cistern was commenced 15 feet below the plain, on a side hill. Six feet below the surface the diggers came upon a solid mass of concrete, composed chiefly of quartz pebbles. Below this was a cavern one foot in height, on the floor of which were the bones above mentioned. There was no outlet to the cave, and it is to be supposed that by the filling up of the

ravine the original opening was closed. In the Marietta Works\* a line of embankments leads from the mound inclosed by a circle to the square containing 27 acres. Recently, in cutting down a portion of this embankment, near the fence, the workmen came upon a circle composed of sandstone pestles and round balls, arranged radially, the balls alternating with the pestles.

MONTFORTH, WARREN. There are located in the vicinity of New Liberty, Owen County, Kentucky, a few mounds. There are a number of mounds in the "bottoms" along the Ohio River, and on the hill-tops not far from the Kentucky River. There are others in secluded spots. One of them, about 50 feet in base diameter, and 15 feet high, is situated at the junction of two small streams, about a mile and a half from the Ohio River, in Gallatin County, surrounded on all sides by high hills. It has been cultivated a number of years and many relics have been found.

NULL, JAMES W., sends the following account of mounds, &c., in the neighborhood of Reel-Foot Lake, in Western Tennessee, a body of water 20 miles long and from 2 to 5 miles wide, formed by the sinking of the earth during the earthquakes of 1811 and 1812. Near Thompson's landing is a group of seven mounds within a space of 3 acres, circular in outline, 5 feet high, and 20 or 25 in diameter. Some were bare, others had large trees growing upon them. A large tree uprooted revealed the structure of one to be a layer of soil over a heap of sand. One-fourth of a mile north is a group of eight, very similar to the former in every respect. A few hundred yards further north is a group consisting of a central mound, about 3 feet high, kidney-shaped, 100 feet long, and 40 to 50 feet wide, surrounded by a number of circular mounds 2 to 3 feet high. Several isolated mounds were discovered larger than those in groups. Dyer, Obion, and Lake Counties are all said to be rich in aboriginal remains.

PALMER, EDWARD, reports mounds and graves at Niles Ferry on the Tennessee River, at Chattanooga, and at points near Nashville.

PEET, S. D., announces that he has been prosecuting the survey of the mounds of Wisconsin during the past year at his own expense.

RICE, H. B., announces the discovery in South Florida of crania having a peculiar shape. "They are without foreheads or depressions at the root of the nose. A number were buried close together, inverted, and in proximity to normal skulls erect in position, all partly decomposed. The crania do not exhibit evidences of flattening."

RUSBY, H. H., describes a cave near Silver City, N. Mex.

\* "Ancient Monuments of the Mississippi Valley," by E. G. Squier and E. H. Davis: plate xxvi.—*Smithsonian Contributions*, vol. i.

STOCKTON, J. B., Toronto, Kans., reports that there are no mounds in that vicinity. A cave near the town is reported to have carvings on the walls.

TANDY, W., of Dallas, Hancock County, Illinois, excavated a mound near that place, which had been the burial place of warriors. All the skeletons were those of adults; ten of the crania and a vertebra having arrow-points sticking in them. There are about thirty mounds in the vicinity of Dallas, of which Mr. Tandy will make a map.

WALKER, S. T., writing from Milton, Florida, makes the following mention of antiquities: "I know of quite a large mound containing bones on the Withlacoochee River, seven miles north of Crystal River post-office, from which human bones have been taken; another is situated 28 miles north of Milton, the most wonderful that I have seen. It is one hundred paces in circumference."

He also states: "I have sailed over five hundred miles, and located many mounds, shell heaps, sites of ancient villages, cemeteries, &c. The most important discovery was that of an ancient canal leading from the head of Horseshoe Bayou into the fresh-water lakes of the interior. This canal is about 10 or 12 feet wide, and must have been originally from 6 to 15 feet deep. It is as straight as an arrow, excepting an obtuse angle in one place. Estimated length, one mile. Large pines grow on the embankments and cypresses, 2 feet in diameter, in the bottom of the trench. The lakes, connected by this canal, are about 7 or 8 miles long, and are famous for the immense numbers of fish which they contain. All along Four-Mile Point shell heaps abound, and low mounds, from 1 to 2 feet high, are scattered through the woods for miles. These were undoubtedly built for residence, each being large enough to accommodate a single house, excepting a few which are large enough for half a dozen. East and west of Four-Mile Point the signs of ancient occupation grow gradually less, especially toward the mouth of Choctawhatchie, where a single sand mound exists. West of this, at Indian Bayou, there is a large domiciliary mound and several shell heaps. No more occur until East Pass is reached, where are several small heaps and a cemetery. The burials seem to have been made in separate graves, some being covered with a species of clay or coquina rock. At Camp Walton, or Brook's farm, on the mainland, at the head of the sound, were discovered fifteen large shell heaps and a large domicile mound, 15 feet high, 135 feet wide, and 300 feet long, containing a layer of shells and some human remains, while all through the hammock there are dozens of small circles of earth, &c. At Black Point, at the mouth of Garnier's Bayou, was found a large sand mound, 10 feet high, with a circular base about 200 feet in diameter, and having a sloping roadway to the top.

"Although no oysters now live in Choctawhatchie Bay, they once existed there in vast numbers. The heaps are composed almost entirely



§ MISCELLANEOUS PAPERS RELATING TO ANTHROPOLOGY.

this shell, and they were as large as they ever grow in this latitude. Scallops also were once numerous, but now are entirely extinct. The cabbage palm and the pelican have also vanished within the memory of old men."

WIGGINS, JOHN B., announces the discovery of the mound where the Indians buried their dead after the battle between the Shawnees and the Nanticokes, at Nanticoke, Hanover Township, Luzerne County, Pa.

WILLIAMSON, GEORGE, calls attention to works near Marksville, La. South of that place is an embankment extending from a bluff on the old channel of the Red or some other river, a distance of a mile or more. The embankment is from 8 to 12 feet high and is flanked on the outside by a wide, deep ditch. In several places appear to have been sally-ports, and large old forest trees are growing on the bank. In the work are two large mounds, one of them covering several acres. In this vicinity are a great many mounds, some of them of great size. The remains are on the first high land on the bank of what was once a river channel, communicating with the Atchafalaya.

WILTHERS, C. J. incloses testimony of A. J. Templeton and Joseph McCrees with reference to finding two tablets in a gravel bank within the corporate limits of Piqua, Ohio, on the land of Wilson Morrow. One of these tablets was 15 feet from the surface, which was covered with 4 feet of loam. On the surface of the object were "characters" and in the center lead inserted. The second was found the next day in the loose gravel which had caved down.

## TUCKAHOE, OR INDIAN BREAD.

BY PROF. J. HOWARD GORE.

Among the many interesting topics relative to the American aborigines, few are more interesting than their means of obtaining subsistence; principally because of its importance as a factor in solving the problem of the primitive population. Procuring food, and waging war, occupying the Indian's whole attention, developed his ingenuity by exercising it, and the degree of skill employed in these pursuits determines the relative status of different tribes. Nearly every writer upon the customs of the Indians has made this the subject of special consideration, and as the early settlers in different parts of America were frequently compelled to resort to the use of Indian foods, on account of failure in their first crops, our historians have dwelt largely upon the food products of the Indians. In regard to the character of the game and the means of obtaining it, there is but little doubt, but in the case of vegetable foods, much that has been written is of no value, since only the common names of the plants and roots were given, on account of the ignorance of the writers on botanical subjects; and, in addition to this, many mistakes have occurred by the change or corruption of the names by which these plants were formerly known. Those who were sufficiently skilled in the identification or the naming of the plants which came under their observations have given us important data for comparing the flora of the country at different periods. Unfortunately, many of the scientific pioneers were so enthusiastic in the discovery of new species that insufficient care was observed in naming plants already described, so that our botanical synonymy has become tangled, and in some cases the specific is not a check for the common name, which, varying in different places and at different times, causes plants to possess impossible properties, that have been ascribed to others once bearing the same common name, and the complicated synonymy sometimes fails to point out the exact inconsistency. An example of the condition of affairs just mentioned is the subject of this paper.

In 1875, while in charge of the museum of Richmond College, Virginia, some specimens of Tuckahoe were received, which elicited considerable interest concerning its production and the methods by which it was obtained, since the donor said that it was once an article of great esteem among the Indians as food. Many questions were asked of the students who came from the locality from whence the specimens were sent, and some correspondence was resorted to in hopes of obtaining

information upon the topics referred to. The very little knowledge thus procured, together with the curious shape of the substance, its traditional use and mysterious propagation, at once suggested that it be made the subject of a careful examination. But, as library facilities were not then available, nor could a definite plan of procedure be determined upon, the investigation was deferred until the beginning of the past year. In order to ascertain all that is now known on this subject, circulars of inquiry were sent, through the Smithsonian Institution, to every cryptogamic botanist throughout the United States, asking for information upon its botanical nature, also to curators of natural-history museums, and a set of queries for publication sent to at least one newspaper in every town along the Atlantic coast from New Jersey to Florida, in the Mississippi Valley and in California, with a request that all the readers who were able would favor me with answers to the questions asked. By these means a large number of specimens were obtained, all of which were identical in their general appearance, showing that wherever it is now found, the same substance bears the same name. Its geographical distribution was also accurately ascertained, and much valuable information relative to the character of its growth and the attending conditions. In the mean time the literature of the subject received especial attention; the various libraries of this city were thoroughly examined, as well as those of Boston and Harvard. The different theories concerning its use and production, the analyses obtained, with a very elaborate one made especially for me, and the record of observed facts, when brought together, gave a medley with so many contradictory elements that it seemed impossible to either reconcile the differences or deduce any satisfactory conclusions therefrom.

The disagreement in the analyses could be accounted for by supposing that either some were wrong, or that the specimens when examined were in different stages of development. But when all (see future part of this article) negatived tradition, as well as the statement made by historians and botanists, that Tuckahoe was nutritious, the outlook was far from cheery.

The only solution then apparent was the supposition that the substance called Tuckahoe by these writers was not the same as the tuber now known by that name. This surmise receives confirmation from a comparison of the following quotations: "*Lycoperdon solidum*, a very large tuber of the ground, outside rough, white within. The Indians use it for making bread, commonly called Tuckahoe" (Clayton, "*Flora Virginica*," p. 176). By referring to the analysis it will be seen that a substance with less than one *per cent.* of nutritive properties could not be used with any success as food, while the description given exactly suits the tuber now called by the same name. So there is some reason in thinking that the property belonging to one root known as Tuckahoe has been ascribed to all roots having that common name. In Fries' "*Systema Mycologicum*," vol. 2, p. 242, we read: "*Pachyma cocos*, oblong,

with a hard scaly bark, with a brown and woody appearance; elliptical in shape and about the size of a man's head, exactly resembling a cocoa nut; bark thick and fibrous, in general appearance like a pine root. Within, the substance is almost white and flesh-like, with an odor like a mushroom. When they attain their growth, the color is white, and they are considered by the natives as possessing medicinal properties. They are found in Carolina, especially among the pine forests." Almost the identical description is given by Von Schweinitz, in "Synopsis Fungorum," p. 56; also in Walter's "Flora Carolina," p. 256.

In order to be able to positively assert that there were more than one root known as Tuckahoe, we must find at least one other whose properties and general appearance will coincide with or take the place of those already given. A search for this was made among the earliest histories of the eastern parts of America. The first promise of success was derived from Smith's "History of Virginia," p. 87, where it is written: "The chief root they have for food is called Tockawhoughé. It grows like a flag in marshes. In one day a savage will gather sufficient for a week. These roots are much of the greatness and taste of potatoes. They used to cover a great many with oak leaves and ferns and then cover all with earth in the manner of a coal pit; over it and on each side they continue a great fire 24 hours before they dare eat it. Raw, it is no better than poison, and being roasted, unless it be tender and heat abated, or sliced and dried in the sun, mixed with sorrel and meal it will prickle the throat extremely, and yet in summer they use this ordinarily for bread." The account given by Smith is confirmed by Beverly, "History of Virginia," p. 153: "Out of the ground they (the Indians) dig earth nuts, wild onions, and a tuberous root they call Tuckahoe, which, while crude, is of a very hot and virulent quality. But they can so manage it, as in case of necessity to make bread of it. It grows like a flag in the miry marshes, having roots of the magnitude and taste of Irish potatoes." Also, in Campbell's "History of Virginia," p. 75: "Of the spontaneous productions of the soil, the principal article of sustenance was the tuckahoe root, of which one man could gather enough in a day to supply him with bread for a week. The Tockawhoughé, as it is called by Smith, was in the summer the principal article of diet among the natives. It grows in marshes like a flag, and resembles somewhat the potato in size and flavor. Raw, it is no better than poison, so that the Indians were accustomed to roast and eat it mixed with sorrel and corn meal. There is another root found in Virginia called Tuckahoe and confounded with the flag-like root described above, and erroneously supposed by many to grow without stem or leaf. It appears to be of the convolvulus species, and is entirely unlike the root eaten by the Jamestown settlers." It is evident from the preceding extracts that at least two dissimilar roots were referred to, so that the supposition that more than one tuber was known as Tuckahoe may now be called a conclusion. The question then remaining is: What was this flag-like root? The Kooyah, or

Tobacco root (*Valeriana edulis*), resembles in several particulars the root described by Smith and Beverly, especially in having its poisonous properties removed by prolonged cooking in the ground. (See Fremont's "First and Second Expeditions," pp. 135 and 160; also Agricultural Report for 1870 p. 409.) But as this species of *Valeriana* is not found so far southeast as Virginia, this surmise will have to be abandoned and another answer sought. I am indebted to Prof. J. Hammond Trumbull for a reference which assisted in the solution of the problem. In Kalm's "Travels," vol. 1, p. 388, we read: "*Tawko* and *Tawking* was the Indian name of another plant, the root of which they eat; some of them call it Tuckah, but most of the Swedes knew it by the name of Tawko. It grows in moist grounds and swamps. This is the *Arum virginicum*, or Virginia Wake Robin." And again: "Tawkee is another plant, so called by the Indians who ate it. Some of them called it Tawkin and others Tackoim; the Swedes called it always by the name of Tawkee; this was the *Orontium aquaticum*" (Golden Club). - - - "Tawho, Tawhim, some call it Tucah. It grows in moist swamps, roots as large as a man's thigh. When fresh, are pungent and considered poisonous. They were cooked in pits. It is the *Arum virginicum*, or Virginia Wake Robin, same as the Tuckahoe of North Carolina" (vol. 1, p. 389). This description agrees with that given by Smith and Beverly, and as it was written by a botanist with sufficient knowledge of the habits of the Indians to speak with accuracy, we feel perfectly safe in accepting his statement, and conclude that Tuckahoe, if not applied exclusively to the *Arum virginicum*, at least included it, and its reputed nutritive properties were obtained from *A. virginicum*, or a similar root, as may also be seen from this quotation from Rafinesque's "Medical Flora," vol. 2, p. 270: " - - all esculent roots were called Tuckahoe, such as *Apios* and potatoes. Tuckhaus is a solid white mass, with wrinkles and gemmules outside; several species seen (3) *rugosus*, *leviusculus*, and *albidus*. *T. rugosus* reaches 40 pounds weight. Fungose, when fresh, hard, brittle like starch when dry, tasteless, inodorous, and esculent, eaten by Indians in many ways." In order to substantiate this theory, we will appeal to language as the final arbiter. We are again pleased to acknowledge our indebtedness to the distinguished ethnologist, Professor Trumbull, who gave us access to his notes. He says: "Tuckahoe, Tawkee [Delaware, *ptucqui*, mass, *petukqui*; Cree, *pittikwow*: round globular.] This name, varied by the dialects of the several tribes, belonged to all esculent bulbous roots used by the Indians, among which are these: *Orontium aquaticum*, Golden Club, and *Pentandria virginica*, Virginia Wake Robin. The word Tuckahoe is generic, and was given to several species, which has misled the botanists and tangled the synonymy. The word is not derived from the Indian word for 'bread' but the word for *loaf* or *cake*, derived from *ptucqui* or *ptuckqueu*, and signifies that which is made round, or rounded." This conclusion was reached before appealing to Dr. Trumbull, and it is a source of great satisfaction to have it indorsed by such

indisputable authority. In the future, then, when we read of the nutritive properties, of Tuckahoe, and that it affords the chief article of sustenance for the Indians, we shall know that nothing more definite was referred to than an edible root.

For the substance now quite familiar as Tuckahoe we will adopt the name *Pachyma cocos* Fr., and proceed with a discussion of its many interesting features, giving, first,

THE SYNONYMS:

*Pachyma cocos*, Fries, vol. 2, p. 242, in 1822.

*solidum*, Oken, p. 93, in 1825.

*pinetorum*, Horaninow, pp. 2-23, in 1856.

*coniferarum*, Horaninow.

*Lycoperdon solidum*, Clayton, p. 176, in 1762.

*sclerocium*, Nuttall, p. 200, in 1820.

*cervinum*, Walter, p. 262, in 1788.

*Sclerocium cocos*, Schweinitz, p. 56, in 1823.

*giganteum*, MacBride, 1817.

*Tuckhaus rugosus*, Rafinesque, vol. 2, p. 255, in 1830.

MacBride stated that Tuckahoe was thought by some to be the root of the *Erythrina herbacea*, or *Convolvulus panduratus* (Trans. Lin. Soc., June 8, 1817), but this supposition is so far from a semblance to truth that these names should not be included in the synonymy. The other names refer to the same substance beyond a doubt, as shown in the case of several by the quotations already made and also by the derivations of the names.

The generic designation *Pachyma* is from *παχυς*—thick—referring to the thick skin; *cocos* from *cocoës*—a cocoa nut, which it resembles. *P. solidum* is evidently given on account of its solid nature, which distinguishes it from other species of *Pachyma*. *P. pinetorum* is from *pinus*—a pine—around whose root it was found, as stated by Fries, in the extract already given; and also von Schweinitz, Am. Phil. Trans. for 1823, p. 264: "I have found it among the pines of Carolina." *Coniferarum* is from *conifer*—cone-bearing—as the pine and fir, as first mentioned. Other botanists, thinking that it was similar to the mushroom in the character of its growth, gave to it the same generic name—*Lycoperdon*—differentiating it from other species by the characteristic which appeared to them the most striking, as *L. solidum*, *L. cervinum*, from *cervinus*—like a stag's horn—a shape which Tuckahoe sometimes assumes.

The first analysis made of it was by Torrey in 1819, which is summarized as follows: In an elaborate analysis of this fungus it was found that no gluten enters into its composition, but that it consists almost entirely of a peculiar vegetable principle, which he calls *sclerotin* (*Silliman's Journal*, v. 2, p. 369). This confirmed the view held by MacBride, that it belonged to the genus *Sclerotium* of Persoon, and, considering it an unnamed species, he was pleased to call it *S. giganteum*. Nuttall,

a year later, thinking that it belonged to the genus *Lycoperdon*, and recognizing its predominating constituent as determined by Torrey, called it *L. sclerocium*. Schweinitz also considered it as belonging to the *Sclerocium* of Persoon, but specialized it by *cocos*, by reason of its external appearance and shape. The appellation of Rafinesque was altogether fanciful—*Tuckhaus*, from the common name Tuckahoe, and *rugosus* from its roughened exterior. So it happened that the synonymy has become so extensive—Not knowing the character of the formation, the manner of reproduction, nor its chemical constituents, each writer, forming a theory of his own, gave it a name in accordance therewith. By general consent we have adopted the name of Fries—*Pachyma cocos*—which will be equally applicable should we be compelled to alter our views upon any or all of its salient features.

The next point to be observed is some of its ascribed

*Affinities.*—It is quite reasonable to suppose that wherever the requisite conditions for the growth or formation of *P. cocos* exist similar structures may be found, with the same or different names. The synonyms just given were all applied to the species found in America, the common name of which is the same in all localities, with various secondary appellations, as “Indian Bread,” “Indian Head,” and “Indian Loaf.” That there is at least one similar tuber in China is shown by Smith, in “*Materia Medica of China*,” p. 166, “*Pachyma cocos*” (Fuhling). This fungal growth, which is both food and medicine for the omnivorous Chinese, is met with in the form of large tubers, having a corrugated, blackish-brown skin, and consisting internally of a hard starchy substance, of a white color, but sometimes tinged with pale or brown, especially towards the outside. The tuber is sometimes perforated by an irregular channel, lined with a red membrane marking its attachment to some root. They are met with on the sites of old fir plantations, or actually connected with living trees. A similar stuff is found in Japan and South Carolina, where it is called Indian bread. It is ground up, mixed with rice-flour, and made into small cakes, which are hawked about all hot in the early morning. They are set down as good in febrile and dyspeptic complaints.” In Clever’s and Hanbury’s “*Materia Medica*” like statements are made. It is known in China by a variety of names, as: Fuhling, Pu-fuhling, Pefolim, and Pu-foohling. In Burmah it is called Tsein aphotaroup. From Dr. Barbeck, of Philadelphia, I have the following information: “*Pachyma tuber regium* Fries (diameter varying from 3 to 5 inches, surface rough and strobiculate) is found in the Moluccas, growing in the ground like our Tuckahoe. It is called by the natives Ubi Radja, Culat-Batu, or Ulta-Batu, and furnishes a favorite remedy for diarrhea, fever, and other diseases. From this *Pachyma* a mushroom (*Agaricus tuber regium* Fr.) is developed, which is edible, though rather poor. Also in China there is a similar *Sclerotium* (size of a child’s head, surface shriveled, color yel-

lowish, in and out side), known as Hoelen or Foelem. It grows in sandy soil, in the province of Teheucu, and is generally esteemed for its medicinal properties." In this country there seems to have been found a plant quite like *P. cocos*, as indicated by the following extract: "Picquotaine, a highly nutritious plant growing in North America and used by the Indians as food. It belongs to one of the species of the genus *Psoralea*, and is temporarily placed by Lamaré Picquot, who first introduced it into France, under the species *esculenta*, of Prusch. In the proportion of one-half or one-third parts farina, makes excellent bread with wheat flour" (Booth & Morfit's "Encyclopædia of Chemistry," p. 832.) These authors considered Picquotaine identical with Tuckahoe, since the above sketch is referred to under the word Tuckahoe. That they are different can be seen by the analysis of Picquotaine, which is: Nitrogenous matter, 4.09; mineral substance, 1.61; starch, 81.80; water, 12.50 (Payen, in Comptes Rendus, for 1848, p. 826).

By comparing this with the analysis of *P. cocos*, it will be seen that it contains six times as much nitrogenous matter as *P. cocos*, while the starch in the former is equal in quantity to the pectine in the latter. So the claim for identity is groundless, and there is but little indication of affinity.

The next topic occupying our attention is its

*Habitat.*—By means of the set of queries sent to various parts of the United States, asking, among other questions, about the prevalence in each locality where it is found, the geographical distribution was accurately determined. The States only will be given, without mentioning the county. It has been found in several places in Delaware as far north as Kent County, New Jersey, New York, Pennsylvania, Virginia, North and South Carolina, Tennessee, Georgia, Mississippi, Kansas, Arkansas, Texas, and Florida. The character of the soil in which it is universally found is a light loam, free from prevalent moisture, and in fields that have not been farmed for several years, especially those from which the timber has been cleared within fifty years past. Not a single specimen has been found in very old fields, nor in wood lands. This however might be from the fact that timber land is not dug up nor plowed—the way *P. cocos* is always found. Even if it were nutritious, this accidental manner of finding it—by no means frequent in plowing several acres—would render it of very little and uncertain service as food. The above requisites for its production being so frequently coexisting, there would appear no natural limit to the extent of *P. cocos*, unless we suppose that a cold climate and a prolonged frozen condition of the ground would prevent its formation. This is quite likely, as it is not found north of Delaware.

*Chemical composition.*—In order to fully determine whether *P. cocos* could possibly be used as an article of food, it was necessary to have a careful analysis made of its substance, especially since the analyses



previously consulted were so different as to attach uncertainty to all. Several specimens for examination were placed in the hands of Professor Colyer, chemist-in-chief of the Agricultural Department, with the result indicated by the following report, prepared by Dr. Henry B. Parsons, assistant chemist, with the concurrence of Professor Colyer:

"The first careful chemical examination of Tuckahoe was made by Prof. John Torrey, in 1819 (New York Medical Repository, vol. 1, p. 37). He found the fungus to consist almost entirely of a hitherto undescribed substance, not starch, which had the property of forming a jelly when heated with water and allowed to cool. To this substance he assigned the name 'sclerotin.' The later researches of Bracconnot on the jelly-forming constituents of fruits and tubers were published in 1824, and led to the adoption of the term 'pectous substances' (Ann. Chim. Phys. vol. xxviii, p. 173). In 1827 Torrey republished his original article with additions, and demonstrated that the substance he had named sclerotin was identical with the pectic acid of Bracconnot (Med. & Phys. Jour., vi, p. 484). In this conclusion he was certainly correct, as this gelatinous substance deports itself exactly like pectic acid, as described in the standard text-books on proximate analysis (Prescott's Prox. Orig. Anal., p. 166). In 1875 an analysis was made at the Bussey Institute. In this the gelatinous substance is spoken of as pectose; in most respects the analysis there made agrees very closely with the one here reported. Trifling differences are to be ascribed to the examination of different samples.

	Department of Agricul- ture.	Bussey In- stitute.	University of Vir- ginia.
Moisture at 110° C.....	12.97	14.57	10.70
Ash.....	.24	.24	3.64
Albuminoids:			
Soluble in alcohol, not in water.....	.28 }		
Soluble in water, not in alcohol.....	.51 } .79	1.38	.75
Carbohydrates:			
Tannin-like substance soluble in water.....	1.25 }		
Gum.....	.20 } 79.88	73.73	75.22
Pectic acid, by difference.....	78.43 }		
Fatty substance soluble in gasoline.....	.35	.34	-----
Crude cellulose.....	5.77	9.80	3.76
Mineral matter.....	-----	-----	3.64

(The other two analyses appended for comparison were not known to Dr. Parsons until after he had finished his. The one made at the University of Virginia was under Professor Mallett's supervision, and can be seen in London Chemical News, No. 832, p. 168.)

The most notable peculiarities of this substance are, the entire absence of starch ("No fungus has yet been found to contain true starch."—Sach's "Botany," p. 241), the comparatively small amounts extracted by solvents, the gelatinous character of the cellulose, and the very small amount of albuminous substance. Nothing else yet analyzed has been reported to contain so large a proportion of pectinous matter. In ordinary fruits, such as are commonly used for making jellies, these pectin

bodies seldom amount to ten percent. According to Sach's Botany, "the origin of colloidal pectin is still unknown." Its nutritive value seems also to be entirely undecided. The older writers considered the pectin bodies of no value as foods, while later authors seem inclined to give them a value approximately that of starch. It seems certain that a diet of Tuckahoe (*P. cocos*) alone would not sustain life, because of the lack of sufficient nitrogenous materials to repair the waste in the animal tissues; still, it might prove a valuable adjunct to highly nitrogenous foods.

Various medicinal properties have been ascribed to *P. cocos*, such as, an antidote to mineral poisons; for poultices on the ulcers that follow yellow fever; diarrhea; cancers; and, the most startling of all—the state ment made in Hobb's "Botanical Hand-Book"—that it is aphrodisiac. It is easy to understand how these properties could be ascribed to Tuckahoe—a representative name for all round or tuberous esculent roots—and now when *P. cocos* is the only root bearing the name of Tuckahoe it retains the traditional virtues of a large part of the Indian materia medica. From the large number of correspondents upon this subject, not one has been found who ever knew of any use to which it has been put. So we may safely conclude that *P. cocos* possesses no practical value; but it is unsurpassed in interest from a botanical standpoint, especially since so little is known concerning its

*Growth or formation.*—To those not familiar with the general appearance of *P. cocos* a description might be acceptable. As already stated, the outside is rough, dark brown in color, in many places considerably wrinkled, looking like the bark of a hickory tree just at the surface of the ground. Upon cutting this bark there will be seen a grain almost as distinct as that in the bark of the oak or hickory, and a woody appearance in other respects. There is not noticeable any membranous division between this bark and the substance within, neither does the one merge into the other, but there is a marked distinction between them. Within we find a compact white mass, without any apparent structure, either vascular or granular. When first taken from the ground it is quite moist, and gives away under pressure; but this moisture is doubtless absorbed from the ground and is not inherent. When dry, this white substance cracks from within and becomes very hard. At all times it is absolutely tasteless, and insoluble in water. Even after a careful and extensive study of the subject, there is still some doubt as to its formation. From a critical inspection of its structure, and an examination of many specimens at different stages of development, together with the confirmatory evidence of numerous correspondents, the following conclusion was reached. At some season of the year spores are given off and transmitted by insects, water, or other natural means, and are attached to the roots of other trees suitable for its production. This doubtless occurs while the tree is in a living condition. These spores have the property of converting the woody fiber of the

FIG. 1.



FIG. 2.

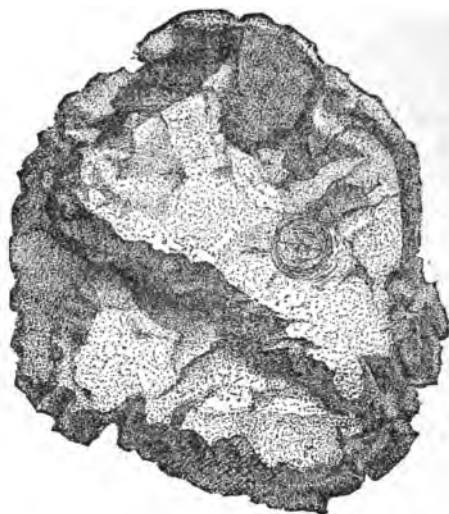
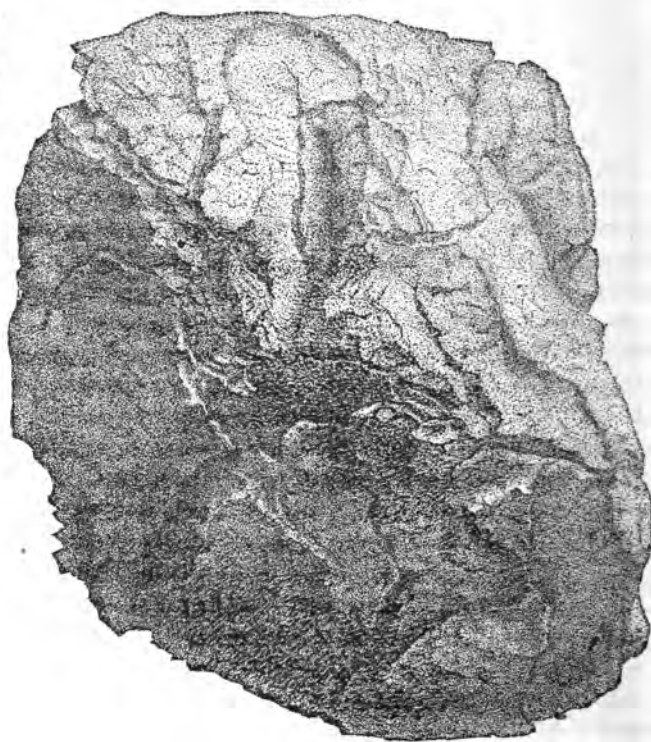


FIG. 3.



FIGS. 1 and 2.—A root with growth of Tuckahoe around it.

FIG. 3—A mass of Tuckahoe.

root into their own substance, which forms underneath the bark. It may also, by stimulating the flow of sap to this point, receive accretions by assimilating the sap, and the periodic giving-off of spores may continue to excite the deposition of sap at this point. It gradually grows in this manner, appropriating the bark of the root for its own covering until it becomes too large, during which process it forms a bark of its own, as already described.

Every link of the above theory is indisputable except the production and transmission of spores. About this there is a shadow of doubt—a shadow only—because the microscope reveals a mycelium, and spore. Specimens in all stages of development are in my possession, from the root, with only a film of the substance between the bark and the woody part of the root up, to pieces of 6 inches in diameter. In the smallest the original bark surrounds the whole, and continues to do so until it attains a thickness of an inch or more. In the largest specimens will be found the root still passing clear through the substance of the *Pachyma*, or scars at both ends marking its previous attachment. The root within the *Pachyma* is always smaller than that just without.

From this fact, as well as the total disappearance of the root in some pieces, we are safe in saying that the wood of the root has been converted into the substance of the *Pachyma*. By way of confirmation, extracts from a few letters will be given :

“At the close of the past winter, having occasion to build a new garden, in land that had never been cleared, we dug and plowed up several pieces of it, some in advanced state of growth, while others had just commenced growing. Several small pines had died on this spot four or five years ago. This growth had taken place from the roots of these pines, as was evident from some having just commenced growing, the pine root extending through and reaching out at each side. . . . Others were developed to considerable size, showing no appearance of any root in them or any bark of the pine on the outside, as was the case with the smaller ones. . . . I think the whole root for 2 inches or more is changed into this substance, from the fact that some of the roots extended entirely through it, some of them being small inside and larger outside.”—(Jonathan Stewart, Barnesville, Ga., June 21, 1880.)

“In almost every case I have observed they have been plainly attached to a root of another growth. I have no doubt they have been, at some time, in every case. This root is usually about one-half or three-quarters of an inch in diameter outside the tuber, frequently larger ; sometimes runs directly through the center of it, sometimes nearer one side than the other. This root is always free from bark inside the tuber, and is often diminished to a slender stick or single fiber, and is sometimes imperceptible, having the appearance of being eaten away more or less, or entirely, in the process of formation.”—(Edwd. Bull, Woodbridge, N. C., April 21, 1880.)

"The Tuckahoe of which this is a part was at least 20 inches in length; the dead root which you see in this ran quite through its whole length, and about which it was formed. The specimen was in a growing condition when found, the growth proceeding towards either end of the root between the bark and heart, showing there was something in the root favorable to its development. The specimen proves that it has no top growth."—(Thos. E. Baker, Fountain Hill, Ark., March 29, 1881.)

In order to determine its botanical character, a searching microscopical examination was necessary; this was prosecuted by Prof. W.H. Seaman, of Howard University, and Prof. Thomas Taylor, microscopist, Agricultural Department. Professor Seaman reports as follows.:

"On February 25, 1881, I received a large fresh Tuckahoe from North Carolina. The interior was soft, white, and crumbly; specific gravity nearly that of water. Boiling made it more mealy; the iodine test gave no reaction. The body of the fungus is composed of short, irregularly-jointed threads of mycelium, somewhat tuberculated, which swell considerably on heating with water. The fungus is covered with a skin or cortical layer much resembling the bark of a young pine tree, beneath which is a dense layer of dark-colored mycelium composed of finer threads, from which at the proper season I should expect to find spores developed."

The appended report of Professor Taylor gives a detailed description of many interesting experiments which I had the pleasure of witnessing. It is my desire to express my satisfaction with the examination made by him—doubtless the most searching and satisfactory ever attempted.

"In my early experiments made some years ago, with Tuckahoe, I was successful only in finding a few very minute spore-like bodies. In these experiments the microscope only was employed, and the Tuckahoe was used in its natural condition. In some recent experiments the difficulties encountered by reason of the opacity of the Tuckahoe, I called in the aid of chemical solvents with very gratifying results. In consequence of the success attending this line of investigation, I made the following experiments:

"First I placed a portion of the crust on a glass plate, pouring over and combining with it a few drops of strong sulphuric acid, which changed it into a pulpy mass. Quickly and before total destruction of the organic matter could take place I examined the mass under the microscope with a power of 75 diameters, and found present a mass of dark-brown mycelium. I have repeated these experiments many times, using different pieces of Tuckahoe, with the same results.

"In the second experiment I placed a section of Tuckahoe, including the brown crust, in a glass vessel containing strong nitric acid. After the lapse of forty-eight hours I found that the larger portion of the

FIG. 4.



FIG. 5.



FIGS. 4 and 5.—Microscopic views of sections of Tuckahoe.

specimen was changed to a transparent jelly. A portion of the transparent crust was examined under powers varying from 25 to 250 diameters. In each case I found in it large quantities of mycelium of a dark-brown color, branched, transparent, and in long fibers or cells, varying from the .002 to the .020 of an inch in diameter.

"I next subjected a section of Tuckahoe to the action of a strong solution of cyanide of potassium for a period of 48 hours. The substance of the Tuckahoe became quite transparent and pasty, color light-amber. On subjecting a portion of this paste to the microscope in the usual way, under a glass cover, masses of mycelium were discovered.

"With a "Beck" inch-and-a-half and No. A eye-piece I can clearly define in nearly every portion mycelium stretching in masses over the whole field in view.

"In the crust of the Tuckahoe, under the acid treatment, the mycelium is of a transparent amber-color, while in the white portions the mycelium is whitish and translucent. In the fourth experiment I cut very thin sections of moistened Tuckahoe, and mounted them in the usual way, dry, and in glycerine. When examined under the microscope a few threads of mycelium were visible, but only at points of rupture. Tuckahoe, whether dry or in watery solution, is opaque, and for this reason, and partly because of the exceeding fineness of the mycelium, the latter is not discovered in quantity by the simple use of the microscope.

"The application of balsam or other mounting fluid has very little effect in rendering its structure transparent, but my experiments have shown that strong alkalies and mineral acids, especially the nitric acid, will render it perfectly transparent and so soft that with slight pressure the pulp is reduced to a thinner condition than can be obtained by the use of any section-cutter.

"Specimens reduced by means of cyanide of potassium may be mounted with a solution of gum-arabic and glycerine. Specimens prepared with acids may be mounted in glycerine temporarily.

"Having succeeded in demonstrating by the methods described that mycelium is present in large quantities in Tuckahoe, I have come to the conclusion that although Tuckahoe may not itself be a fungus in the strict sense of the word, it is probable that it is caused by the mycelium of a fungus acting on the roots of trees on which Tuckahoe is found.

"The outer surface is a bark-like crust which appears to consist of large cellulose cells, and between this outer crust and the inner white substance is a thin and dark layer about an eighth of an inch in thickness of amber-colored pectic acid, cob-webbed through with masses of dark-brown mycelium."

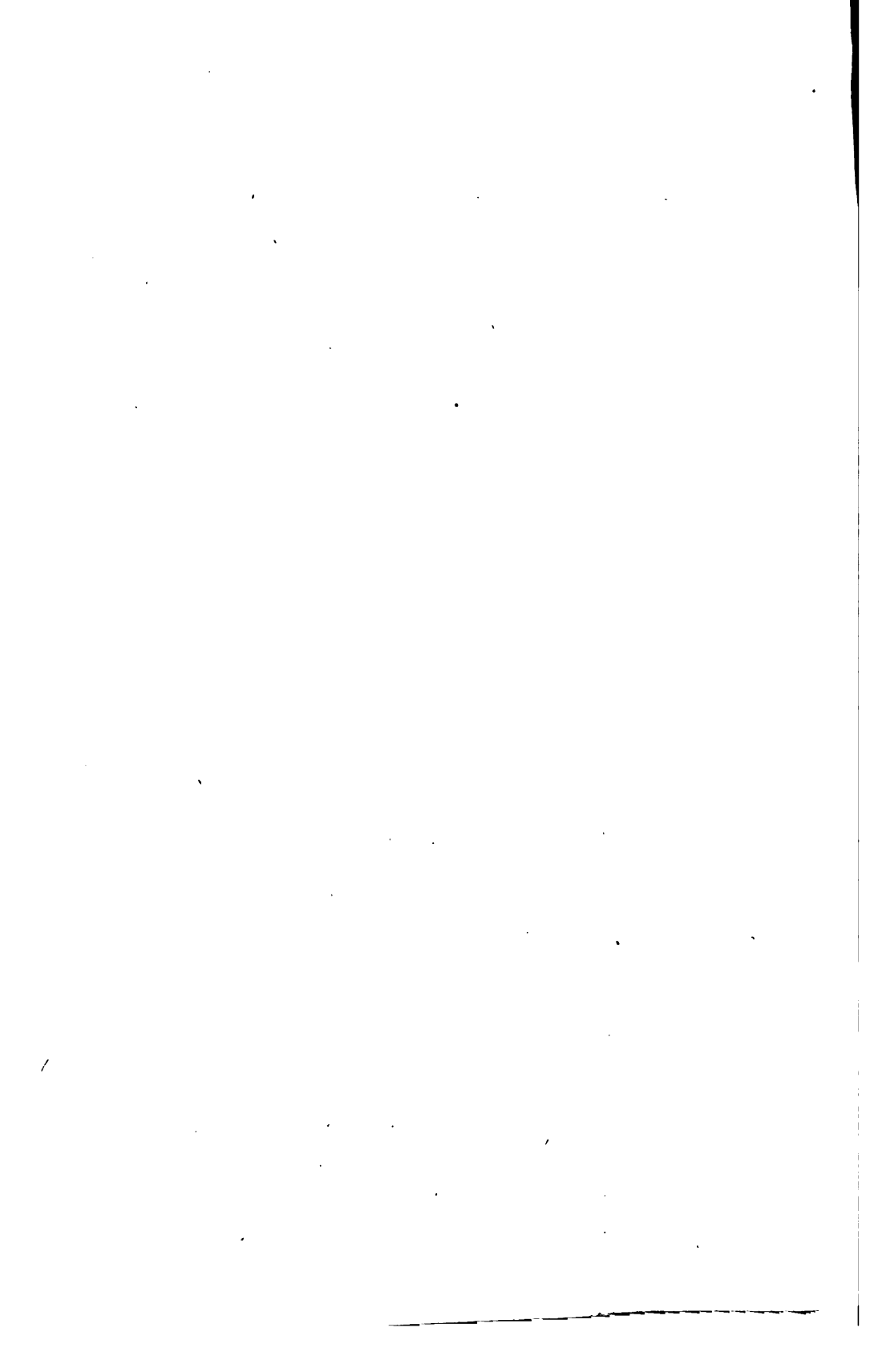
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can be obtained. The following list is perhaps far from complete, but it embraces all the works which treat of *Pachyma cocos* under its own name, or one of synonyms, that were found among the many hundreds that were examined:

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## HISTORY OF THE SMITHSONIAN EXCHANGES.

By GEORGE H. BOEHMER.

### INTRODUCTORY SKETCH OF EARLY EFFORTS IN INTERNATIONAL EXCHANGE.

Before giving an account of the system of literary and scientific exchanges, organized and first carried into effect by the Smithsonian Institution in 1850, it may be appropriate, for indicating more clearly its precise character and importance, to briefly notice previous attempts in a similar direction. One of the earliest of such undertakings is thus set forth in a history of the Royal Library of France:

"In 1694 the Royal Library of France exchanged its duplicate volumes for new books printed in foreign countries. This kind of trade, authorized by the special order of the King (Louis XIV) and continued for several years, could not fail to supply the library with a very considerable accession of valuable books, especially from England and Germany. In 1697 one hundred and forty-nine Chinese books were received, in return for which the King gave a selection from all his engravings." (*Essai historique sur la Bibliothèque du Roi.*)

In our own country the American Philosophical Society, founded at Philadelphia in 1743, and the American Academy of Arts and Sciences, founded at Boston in 1780, commenced about the beginning of the present century a system of international exchange of their proceedings and transactions with those of foreign scientific societies.

In 1832 M. Lichtenthaler, director of the Royal Library of Munich (Bavaria), in a letter dated January 22 of that year, addressed to M. Alexandre Vattemare, of Paris, referring to a conversation previously held between them, recalls the large number of duplicates in the Munich Library, and asks: "Would it not be possible, with your connections at Paris, to interest the Bureau of Fine Arts in adopting an exchange with our library?" This letter appears to have given Mr. Vattemare the impulse to enter upon the execution of a favorite project—the establishment of a system of library exchanges. He secured the approval of his plans, and in a measure promise of co-operation on the part of the King of Prussia (letter of Count Charles Briehl, director-general of the museum) and of the King of Denmark (letter of the scientist, Mr. Hank). At the court of St. Petersburg he was introduced by a letter of King Frederick William IV, of Prussia, to his sister, the Empress of Russia.

In 1833 he went to Vienna and addressed the Count Maurice of Dietrichstein, director general of the Imperial Museum, who replied, on the 6th of December, 1833, by letter, that the preparation of a catalogue of duplicates in the library would require more time than he could just then devote to the subject; but that, nevertheless, Mr. Vattemare might depend on his assistance, and he further expressed his belief that, through Mr. Vattemare's intervention, the library would be greatly benefited.

He had now received favorable consideration from a number of sovereigns and governments which were waiting for France to take the initiative. Knowing that in laying his propositions before his government he must be prepared to support them in an incontrovertible manner by facts, and possessing now official evidence of the favorable reception accorded them abroad, Mr. Vattemare returned to Paris in November, 1835.

In his first petition to the two Chambers he set forth the fact that "all the large establishments founded by the munificence of governments in the interest of science and arts, namely, museums, collections, galleries, and libraries, possessed, besides the treasures they displayed, many others, which by reason of their abundance were condemned to be useless. The duplicates which formed this precious waste, the savant saw with regret, buried in the dust of forgetfulness"; and "there was not one large city in Europe which did not possess a considerable number of such duplicates. The library at Munich had 200,000; Jena, 12,000; St. Petersburg, 54,000; Vienna, more than 30,000, which includes a large number of these 'incurables,' which were hidden away in store-rooms. At Vienna 25,000 duplicates were encumbering the entomological section of the Brazilian museum. Any attempt at enumeration would be imperfect, for everywhere there would be discovered, in addition to those collections of books intended for study or exhibited as curiosities to the public, hidden collections, unknown libraries and museums, treasures lost to science and the world," &c.

The report on this petition was made to both Chambers in March, 1836. The proposition was favorably received. Two years, however, elapsed without any action being taken, the government being engrossed by political events.

Mr. Vattemare, becoming impatient at the delay, resolved to go to England for the purpose of propagandism. He laid his project before the Marquis of Landsdowne in May, 1838, and succeeded in establishing an exchange with the British Museum.

After his return to Paris, Mr. Vattemare addressed a second petition to the Chambers on February 2, 1839, in which he stated an important fact. He said: "For two years the system of exchanges of duplicates has been in operation to some extent. Austria, Prussia, and England have obtained important results, and the greater number of the duplicates at Vienna, Berlin, and Munich, of whose existence mention was

made in my first petition, have enriched other libraries, and are lost to us."

Upon this the Chambers seemed desirous of taking more effective measures, but the administration remaining inactive, matters remained at the same point as in 1836.

At the suggestion of one of the deputies that it would be desirable also to make an arrangement for exchanges with the United States, Mr. Vattemare resolved to visit America. He left Havre October 20, 1839, and arrived at New York November 29, 1839. After taking some preliminary steps in New York he left for Louisiana. On the way he aroused the interest of the Société Royale Patriotique de la Havane in the project of establishing exchanges.

On the 26th of March, 1840, the legislature of Louisiana voted \$3,000 for the collection of material for exchanges.

Mr. Vattemare then went to Albany, N. Y., where he arrived two days before the adjourning of the State legislature. He had a memoir presented to the senate, which body approved the plan and voted an annual appropriation for the purpose of exchanges.

Wherever Mr. Vattemare went his views were indorsed. On reaching Washington the session of Congress was nearing its end, and important measures were being considered. Many influential men assured Mr. Vattemare that the moment was not a propitious one for his cause, but he persevered in his efforts, which were finally crowned by success.

On June 5, 1840, in the Senate of the United States, Mr. Preston, chairman of the Committee on the Library, presented a favorable report on Mr. Vattemare's memorial, setting forth: "There are now in the possession of Congress many hundred volumes of public documents, some of which might well be distributed among friendly governments; and, for a like return, and at a very small expense, permanent provision might be made to supply them in future. As in this department of publication we probably exceed most foreign nations, the exchange would be equalized by receiving in return national works of science or art, which the more ample powers of other governments enable them to execute. Besides this not inconsiderable means of profitable exchange, Congress also has, occasionally, the disposition of duplicate books in the Library."

The committee's report concluded by recommending the passage of a joint resolution, authorizing such exchanges of duplicate volumes in the Congressional Library, and also of a limited number of public documents. The report also published several of the testimonials from distinguished persons presented by Mr. Vattemare, abstracts of which are here given.

[From his excellency Alexandre de Mordwinoff, St. Petersburg.]

"I have the honor to inform you that His Majesty the Emperor, having been made acquainted with your proposition respecting the establishment of a system of general exchange of duplicates, has perfectly

approved your idea ; and you are requested, sir, to present a prospectus clearly setting forth your plan for effecting that object."

[From M. Guizot, minister of public instruction of France, December 31, 1835.]

"I have examined with much attention the plan which you have submitted to me. The considerations adduced by you in support of this plan appear to me to be of such a nature as to entitle them to attention ; and I ardently desire that it may be possible for me to put it into execution."

[From M. de Lamartine, member of the Chamber of Deputies of France, April 10, 1836.]

"Your plan for a general exchange of duplicates between all libraries is excellent. It would aid us in completing our collections which are already so rich ; but it would also have another and happier effect ; it would introduce into France all the ideas of Europe, and would spread through Europe all the ideas of France. Thus, by means of simple exchanges, this diffusion of information—the object of so many of our cares and labors—will be effected."

[From M. Eugene de Monglave, of the Historical Institute of France, March 12, 1836.]

"Your idea, dear sir, is a grand and generous one, which ought to succeed, and which every studious man should encourage by all means in his power. The Chamber of Deputies has offered you its aid, and you will doubtless also receive that of the Chamber of Peers."

[From the Duc de Broglie, minister of foreign affairs of France, June 12, 1835.]

"The minister of foreign affairs has read, with great interest, the letter which M. Vattemare has done him the honor to address to him, respecting the establishment of a system of exchanges between the different libraries of Europe possessing several copies of the same works. The usefulness of the labors undertaken by M. Vattemare, with the view of facilitating such exchanges, seems to be unquestionable ; and the minister of foreign affairs will embrace the earliest occasion to speak to his colleague, the minister of public instruction, upon the plans formed by M. Vattemare."

[Extract from the speech of the Marquis de Laplace in the Chamber of Peers of France, March 30, 1836.]

"I believe it to be the duty of our government to encourage and to protect such an enterprise, and that it becomes France to take the lead in a measure which may produce such desirable results. Such publicity will draw out invaluable works, which are not sufficiently appreciated by their owners, from the dust of oblivion and from their obscure retreats. How many manuscripts thus buried and lost to the world may be restored to light, and shall we not congratulate ourselves for having made private interest contribute to so great a work ?"

[From Gulian C. Verplanck, New York, December 3, 1839.]

"The high and numerous attestations given to your plan of literary and scientific exchanges by the most eminent scholars and public men of Europe, and the eloquent manner in which several of them have stated its philanthropic objects and beneficial results, leave me little to say on those heads. . . . I admire the zeal and devotion with which you have applied yourself to the execution of this unpretending but beneficial plan."

[From Washington Irving, Albany, N. Y., May 7, 1840.]

"I regret extremely that engagements which require my departure for New York will prevent my having the pleasure of attending at the meeting to be held this evening for the consideration of your plan for a system of exchanges between governments and learned institutions, throughout the civilized world, of duplicate specimens in natural history and productions in literature. It is a noble and magnanimous scheme, worthy of the civilization of the age, and the advantages of which are so obvious and striking that they must strike every intelligent mind at a single glance."

[From Joel R. Poinsett, Secretary of War, Washington, December 18, 1839.]

"I regard the subject of your memorial as highly interesting, useful, and important, and it will command my warm support."

In accordance with the recommendation of Mr. Preston's committee, the following act was passed by Congress July 20, 1840 (Vol. V, Statutes at Large, p. 509):

Joint Resolution for the exchange of books and public documents for foreign publications.

*Be it resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the Librarian, under the supervision of the Committee on the Library, be authorized to exchange such duplicates as may be in the Library for other books or works.*

Second. That he be authorized in the same way to exchange documents.

Third. That hereafter fifty additional copies of the documents printed by order of either House be printed and bound for the purpose of exchange in foreign countries.

Mr. Vattemare also visited Canada in 1841, and his mission was equally successful there. In the summer of 1841 he returned to France and immediately presented a third petition to the Chambers, referring to his success in America. The report of the Count of Montesquiou to the Chamber of Peers was sent back to the ministry of foreign affairs and public instruction, but no more was heard from it.

Now, however, Mr. Vattemare commenced the distribution of the objects intrusted to him for exchange. Some had their destination assigned them, but the distribution of the greater number was left to Mr.

Vattemare's discretion. He transmitted the legislative documents to the chambers, elementary books of education, &c., to the ministers of public instruction, &c.

The cities of Boston, New York, Baltimore, and Washington had presented certain works and documents to the city of Paris. On December 21, 1842, it was resolved to address a letter of thanks to the former cities and to send them books in exchange for those received from them.

Mr. Vattemare received from the chambers, departments, and those scientific institutions which had been included in his first distribution a great number of important works. He also made an appeal to savans, authors, and artists, from whom he received some contributions.

The sendings to the United States had been gradually growing larger from the year 1842, and on the 1st of January, 1846, 6,000 volumes had passed between France and the United States. The following year their number reached 8,000.

Mr. Vattemare concluded to personally deliver a large amount of exchanges, and he started on May 10, 1847, with sixty-one boxes.

The custom-house charges at New York being very heavy, he addressed the Secretary of the Treasury, explaining to him that the exchanges from the United States were allowed free entry in France, and in reply the same privilege was granted for the French exchanges.

On his second visit to the United States Mr. Vattemare was equally successful; he forwarded in the course of the year 1848, forty-eight cases to France.

On the 26th of June of the same year Congress charged the Library Committee with the nomination of an agent to conduct the operations of the exchanges between France and the United States. The committee unanimously designated Mr. Vattemare, who entered upon his duties July 25, 1848. It was also resolved that everything transmitted by this agent should be admitted in this country free of duty.

The French Government failing to give further support to the service of international exchanges, notwithstanding the renewed efforts of Mr. Vattemare, its operations ceased at his death, in 1864.

Another movement in our country to effect a system of exchanges (chiefly directed, however, to natural history specimens) was made by the "National Institution" organized at Washington, D. C., in May, 1840. Early in 1841 the institution addressed a circular to the principal scientific institutions of Europe, soliciting their correspondence. A letter to the corresponding secretary from Dr. H. G. Brown, professor in the University of Heidelberg, Germany, proposed, "if acceptable to you I offer an exchange of the petrifications of your country for those of Germany and the neighboring countries." In September, 1841, the United States consul at Lima, Peru, offered to the institution his valuable entomological collections. Almost simultaneously M. Dufresnoy, of the Royal School of mines at Paris, wrote that he had delivered to Mr. D. B. Warden (formerly consul of the United States at Paris) a box of

specimens of mineralogy for deposit in the cabinet of the National Institution at Washington, expressing the hope that such transmissions may become frequent.

In December, 1841, Dr. E. Foreman, of Baltimore, proposed to the institution a plan for obtaining conchological specimens from all parts of the country by a system of exchange. In pursuance of a resolution of the institution adopted December 13, 1841, a committee appointed to propose a plan of exchanges reported February 14, 1842, first, "that a system of exchanges is of very great importance in the accomplishment of one of the primary objects for which the National Institution has been declared to be formed, viz, the establishment of a national museum of natural history," &c.; and second, "that in exchanges of all kinds the natural productions of our country shall first and always have a decided preference. This method, while it recommends itself to us and our interests, is calculated to extend benefits and encouragement to the societies and naturalists of our country, who will thus have a central depository, from which they may enlarge and vary their own collections; and thus also in due time the duplicates of the exploring expedition may with the greatest advantage be diffused throughout the land, thereby fulfilling in the amplest manner the intentions of those who formed that noble project, and justify the liberality of the government which supported it."

And the committee recommended:

"1. That a system of exchanges be entered upon without delay.

"2. That the curator and assistants be directed, for this purpose, to separate all duplicates, except those from the exploring expedition; and that they select and label such specimens as are to be sent to individuals or societies.

"3. That the first step taken be to discharge the obligations of exchange already incurred by the institution.

"4. That a committee be appointed, to whom the curator shall submit all sets of specimens thus set aside for any given exchanges, who shall decide upon the equivalency before said specimens shall be boxed up and sent off.

"3. That in all cases of difficulty which may arise, reference must be made to the president or vice-president of the institution for decision, who will, if they conceive it necessary, submit the question to the institution.

"6. That a book be kept by the curator, subject at all times to the inspection of the committee, in which must be noted the contents of each box or package, lists of the articles for which they are the equivalents, the name and the place of the society or individual to whom one set is to be sent, and from whom the other has been received."

In July, 1842, the institution adopted the name "National Institute."

It will thus be seen that the efforts of the National Institute towards the establishment of a system of exchanges were mainly intended to



enrich its cabinet of natural history, although the exchange of books was not excluded. In this way its museum obtained many valuable additions during the succeeding years, but the financial condition of the institute prevented a vigorous execution of the system. Notwithstanding several appeals to Congress for aid, of which the last one was made on December 16, 1845, nothing was done toward giving the desired relief, and on the 25th of November, 1846, the following "notice to the members of the National Institute" was published, which will give a fair insight into its condition :

"A reference to the last 'memorial to Congress,' which was presented to the Senate by the Hon. Lewis Cass and to the House of Representatives by the venerable John Quincy Adams, will afford the members some idea of the present condition of the National Institute. Notwithstanding that renewed appeal, Congress has again omitted to grant relief. More than a thousand boxes, barrels, trunks, &c., embracing collections of value and rarity in literature, in the arts, and in natural history, remain on hand unopened, the liberal contributions of members at home and abroad, of governments, of learned and scientific societies and institutions, of foreign countries and of our own, and of munificent friends and patrons in every part of the world. The worth, extent, and American interests of these collections may be understood, though imperfectly, by a perusal of the four bulletins which are now before the public. For the preservation, reception, and display of these the institute has neither funds nor a suitable depository. The usual meetings of the members have been suspended for a considerable period. Hence the regular proceedings have been interrupted, and hence the present volume (which has been published by the subscription of a few members and others, a subscription so limited as to have rendered it indispensably necessary to abridge the publication within the narrowest possible compass), instead of presenting in the usual form the proceedings of the institute, gives a mere and meager abstract of a voluminous and valuable correspondence, and an imperfect account of donations and contributions to its library and cabinet."

And thus with the year 1846 virtually ceased the activity of the National Institute in that direction.

From this sketch it will be seen that the system introduced by the two early scientific institutions of our country had in view mainly the interchange of their own transactions for those of foreign societies, for their own benefit and the extension of their own reputation, and that the system introduced in France had in view mainly the interchange among public libraries of their superfluous duplicates and of government publications. The Smithsonian Institution, starting out with the same system, at a very early date in its history inaugurated the original enterprise of furthering the mutual interchange of scientific transactions and publications throughout the world, without reference to any direct benefit to itself by reason of such exchanges.

## SMITHSONIAN EXCHANGES.

Among the definite lines of policy adopted by the Institution at the commencement of its operations was that of a diffusion of its publications, resulting in a system of exchange not limited to the distribution of unused duplicate volumes accumulated in libraries, but comprehending a full interchange of the intellectual products of the two hemispheres.

In the original "programme of organization" presented to the Board of Regents by Prof. Joseph Henry, December 8, 1847, this object was set forth, and in the explanations and illustrations of the programme the consideration was urged that the publication of a series of volumes of original memoirs would afford the Smithsonian Institution the most ready means of entering into friendly relations and correspondence with all the learned societies in the world and of enriching its library with their current transactions and proceedings.

A committee of the American Academy of Arts and Sciences appointed to consider the plan proposed for the organization of the Smithsonian Institution reported, December 7, 1847, on this feature, that "it can scarcely be doubted that an important impulse would be given by the Smithsonian Institution in this way to the cultivation of scientific pursuits, while the extensive and widely ramified system of distribution and exchange, by which the publications are to be distributed throughout the United States and the world, would insure them a circulation which works of science could scarcely attain in any other way."

The first volume of the Smithsonian "Contributions to Knowledge," a memoir on the ancient monuments of the Mississippi Valley (by Messrs. Squier & Davis), was published in 360 quarto pages in 1848, and during the following year was distributed to learned societies in the following countries:

	No. of societies.		No. of societies.
In Middle and South America:		In Europe—Continued:	
Cuba, Havana .....	1	Belgium .....	6
Chili, Santiago .....	2	Denmark .....	3
New Grenada, Bogota .....	1	France .....	25
Venezuela, Caracas .....	1	Germany .....	28
Brazil, Rio Janeiro .....	1	Great Britain and Ireland .....	41
In Africa:		Greece .....	1
Egypt, Cairo .....	1	Holland .....	6
In Asia:		Italy .....	16
China, Hong-Kong .....	1	Norway .....	2
India, Allahabad, Bombay, Ceylon, and Madras .....	5	Portugal .....	1
Java, Batavia .....	1	Russia .....	6
Philippine Islands, Manila .....	1	Spain .....	3
In Europe:		Sweden .....	5
Austria .....	9	Switzerland .....	7
		Turkey .....	1

In addition, the volume was liberally distributed to distinguished savans interested in its subject, and to numerous institutions throughout our own country.

At the commencement of its system of exchanges, the Institution was much trammelled by the great delays and considerable expenses attendant on custom-house requirements, but by earnest efforts and proper representation to Congress, the United States Government adopted the enlightened policy of admitting through our custom-houses, duty free, all scientific publications from foreign countries addressed to the Smithsonian Institution, whether for its own use or as presents to learned societies and individuals in any part of our country.

The efforts of the Institution were then directed to the procurement from foreign governments of a reciprocal liberality on their part. The following extract from the Secretary's report for 1851 will sufficiently indicate the steps first taken :

"The promotion of knowledge is much retarded by the difficulties experienced in the way of a free intercourse between scientific and literary societies in different parts of the world. In carrying on the exchange of the Smithsonian volumes, it was necessary to appoint a number of agents. Some of these are American consuls, and other responsible individuals, who have undertaken in most cases to transact the business free of all charge, and in others for but little more than the actual expense incurred. These agencies being established, other exchanges could be carried on through them, and our means of conveyance, at the slight additional expense owing to the small increase of weight; and we have accordingly offered the privileges of sending and receiving small packages through our agency to institutions of learning, and in some cases to individuals who chose to avail themselves of it; the offer has been accepted by a number of institutions, and the result cannot fail to prove highly beneficial, by promoting a more ready communication between the literature and science of this country and the world abroad.

"As a part of the same system, application was made through Sir Henry Bulwer, the British minister at Washington, for a remission of duties on packages intended for Great Britain, and we are informed that a permanent arrangement will probably be made through the agency of the Royal Society for the free passage through the English custom-houses of all packages from this Institution.

"The Smithsonian exchanges are under the special charge of Professor Baird, who has been unwearied in his exertions to collect proper materials, and to reduce the whole to such order as will combine security with rapidity of transmission.

"The system of exchanges here described has no connection with that established between national governments by Mr. Vattemare. It is merely an extension of one which has been in operation, on a small

scale, for nearly half a century, between the American Philosophical Society and the American Academy of Arts and Sciences on this side of the Atlantic, and the several scientific societies on the other."

Early in 1852 Professor Henry addressed a communication to the vice-president of the Royal Society of London, Col. Edward Sabine, with a view of obtaining the influence and co-operation of that distinguished body in the promotion of an unrestrained scientific interchange between the two great English countries.

This communication received a very prompt and favorable consideration from that society, and the following official response was placed by Professor Henry before the Board of Regents at its meeting, May 1, 1852:

Royal Society's Apartments,  
Somerset House, London, March 19, 1852.

Prof. JOSEPH HENRY:

MY DEAR SIR: I duly communicated to the Earl of Rosse, president of the Royal Society, your letter to me on the subjects of the interchange of scientific publications between the United States and this country, and the admission into England, duty free, of scientific books and memoirs presented to institutions or to individuals here, either by or through the Smithsonian Institution. I accompanied this communication by a letter addressed to the president, which you will read in the inclosed printed minutes of the council of the Royal Society of January 15, 1852. The subject has since been brought by the Earl of Rosse under the consideration of Her Majesty's Government, who have shown, as might be expected, much readiness to meet in the same spirit the liberal example which has been set by the United States, in exempting from duty scientific books sent as presents from this country to the Smithsonian Institution, and through that Institution to other institutions and to individuals cultivating science in the United States. The move which has been suggested by our board of customs for admitting, duty free, scientific publications designed for this country, and which we hope will receive the approval of the treasury, is, that a list should be furnished by the Royal Society of the names of all institutions and individuals to whom such works may be expected to be addressed, when the custom-house officers will have directions to pass without duty all such publications having the names of such institutions or persons inscribed either on the cover or on the title-page, which are sent to this country in packages directed to the Royal Society, the list to be amended or extended from time to time. The Royal Society will gladly take charge of, and distribute under these regulations, the books which the Smithsonian Institution may send for institutions and individuals in this country, receiving them from the agent in London appointed by the Smithsonian Institution; and I shall be obliged by your furnishing me, at your earliest convenience, with a list, as complete as you may

be able to make it, of the names of the institutions and persons to whom books or memoirs are likely to be sent.

The Royal Society will also gladly receive and forward to their ultimate destination (where such assistance may be useful) packages containing publications of a similar description, designed for institutions and individuals on the continent of Europe; such packages being directed to the Royal Society, and stated on the outside of the case or package to be *from the Smithsonian Institution*. The customs duties will, in such cases, be either altogether remitted or returned on re-exportation.

If it be a convenience to the cultivators of science in the United States, that publications presented to them by institutions or individuals on the continent of Europe, or elsewhere, should be addressed to the Royal Society as a channel of communication, the same facilities will be given by the board of customs, and the Royal Society will, with pleasure, make the required arrangements. It will be necessary, in such cases, that packages arriving from the continent of Europe or elsewhere should be marked on the outside, "for the Smithsonian Institution," and the foreign secretary of the Royal Society should be apprised of their being sent. Expenses of freight would of course be defrayed by the agent of the Smithsonian Institution.

I am, my dear sir, with great respect and regard, very sincerely yours,

EDWARD SABINE,

*Vice-President and Treasurer of the Royal Society.*

This, though an important concession, was still attended with considerable delay, and on farther solicitation the rule was so relaxed that all duties were remitted on books, not foreign reprints of British copyrights.

Colonel Sabine's views on the subject were laid before the British Association in his address as president of that body, on occasion of their annual meeting in 1852, as follows:

"Another subject which has occupied the attention of the parliamentary committee in the last year is one to which their attention was requested by the council of the association, with a view of carrying into effect the desire of the general committee for a more cheap and rapid international communication of scientific publications. The credit of the first move towards the accomplishment of this desirable object is due to the Government of the United States, by whom an arrangement was made for the admission, duty free, of all scientific books addressed as presents from foreign countries to all institutions and individuals cultivating science in that country, such books being sent through the Smithsonian Institution, by whom their distribution to their respective destinations was undertaken. This arrangement was notified to our government through the British minister at Washington, and a similar privilege was at the same time requested for the admission, duty free, into England, of books sent as presents from the United States to public

institutions and individuals cultivating science in this country, under such regulations as might appear most fitting. This proposition gave rise to communications between the president of the Royal Society and the chairman of the parliamentary committee on the one part, and the treasury and the principal commissioner of customs on the other; the result of which has been the concession of the privilege of admission, duty free, into England, of scientific books from all countries, designed as presents to institutions and individuals named in lists to be prepared from time to time by the Royal Society, after communication with other scientific societies recognized by charter—under the regulation, however, that the books are to be imported in cases, addressed to and passing through the Royal Society. This arrangement has come into operation; and it may be interesting to notice, as giving some idea of its extensive bearing, that the first arrival from the United States, which has taken place under these regulations, consists of packages weighing in all not less than three tons.

“There is another branch of the same subject which is more difficult to arrange, viz, the international communication by post of scientific pamphlets and papers at reduced rates of postage. The parliamentary committee have directed their attention to this part of the subject also; and I earnestly hope that their exertions will be successful.”

In his annual report for 1852 Professor Henry states:

“The whole number of articles received during 1852 is 4,744, which is more than three times that of all the previous years. The publications received in many cases consist of entire sets of transactions, the earlier volumes of which are out of print and cannot be purchased. They are of use in carrying on the various investigations of the Institution, and of value to the country as works of reference.

“The principal object, however, of the distribution of the Smithsonian volumes is not to procure a large library in exchange, but to diffuse among men a knowledge of the new truths discovered by the agency of the Smithsonian fund. The worth and importance of the Institution is not to be estimated by what it accumulates within the walls of its building, but by what it sends forth to the world. Its great mission is to facilitate the use of implements of research, and to diffuse the knowledge which this use may develop. The Smithsonian publications are sent to some institutions abroad, and to the greater majority of those at home, without any return except, in some cases, that of co-operation in meteorological and other observations.

“In carrying out this plan the Institution is much indebted to the liberal course adopted by the Government of Great Britain and the ready co-operation of the Royal Society of London. All packages intended for Great Britain, for some parts of the Continent, and the East Indies, are directed to the Royal Society, and on the certificate of its president are, by a special order of the government, admitted duty free, and without the delay and risk of inspection. The packages are after-

wards distributed by the agent of the Institution, or by those of the society.

"This system of exchanges does not stop here. The Royal Society has adopted the same plan with reference to Great Britain and all other parts of the world; and the Smithsonian Institution, in turn, becomes an agent in receiving and distributing all packages which the society desires to send to this country. A general system of international communication, first started by this Institution for the distribution of its own publications, has thus been established which will tend to render the results of the labors of each country in the line of literature and science common to all, and to produce a community of interest and of relations of the highest importance to the advancement of knowledge and of kindly feeling among men."

So rapidly and generally was the beneficent work of the Smithsonian Institution recognized and appreciated abroad, that in his report for the year 1854 the secretary—Professor Henry—announced: "There is no port to which the Smithsonian parcels are shipped where duties are charged on them, a certified invoice of contents by the secretary being sufficient to pass them through the custom-house free of duty. On the other hand, all packages addressed to the Institution arriving at the ports of the United States, are admitted, without detention, duty free. This system of exchange is therefore the most extensive and efficient which has ever been established in any country." And in the following year, 1855, the secretary remarked in continuation of the subject: "The Smithsonian agency is not confined to the transmission of works from the United States, but is extended to those from Canada, South and Central America, and in its foreign relations embraces every part of the civilized world. It is a ground of just congratulations to the Regents that the Institution, by means of this part of the plan of its organization, is able to do so much towards the advance of knowledge."

The system of international exchange of literary and scientific productions thus established, naturally developed into two distinct branches:

The *foreign exchange*, or the distribution abroad of publications by the Smithsonian and by other American institutions.

The *domestic exchange*, or the distribution within the United States of publications by foreign establishments.

To this might be added, as a third branch, the introduction in 1867 of a separate system of *government exchange*.

## I. FOREIGN EXCHANGES.

The Smithsonian Institution, in undertaking to extend the system of international exchange of literary and scientific publications, communicated its purpose to the chief learned societies throughout the country, with a proffer of its services to the end in view. The princi-

pal bodies responding to its invitation were the American Academy of Arts and Sciences, Boston; the Boston Natural History Society, the Philadelphia Academy of Natural Sciences, the United States Coast Survey, the Naval Observatory at Washington, and a few others. The Hon. Luke Lea, Commissioner of Indian Affairs, at the instance of the Institution (seconded by the authors), embraced the opportunity of presenting to about one hundred and fifty establishments in Europe (selected from the Smithsonian list) copies of Schoolcraft's History of the Indian tribes. In this case the Institution requested the recipients to return a special acknowledgment to the Commissioner of the Indian Bureau. Numerous documents of scientific interest published by Congress were, through the personal liberality of members in distributing their copies, received from the Senate document room for transmission abroad. The Senate also assigned to the Institution three hundred copies of Foster and Whitney's report on the copper lands of Lake Superior; one hundred copies of Owen's report on the geology of Iowa, Wisconsin, and Minnesota; and one hundred copies of Stansbury's report on the exploration of Utah, for foreign distribution.

In the Smithsonian report for 1854, the secretary states: "During the past year the number of societies availing themselves of the facilities thus offered has largely increased, including among others nearly all the State agricultural societies of America publishing transactions. This result has been produced by a circular which was issued by the Institution early in the spring of last year, to make known more generally the system of exchange. Copious returns are being constantly received for the societies, and an intercourse is thus established which cannot fail to produce important results, both in an intellectual and moral point of view."

As an indication of some of the incidental benefits conferred by this extensive system of exchange, a few special transmissions may be cited.

In 1867, at the suggestion of Hon. John Bigelow, late American minister to France, a request was made by the Institution that some of the principal publishers of school-books in this country would furnish copies of their elementary text-books, in order that these might be presented to Professor E. Laboulaye, of the College of France, for examination, with a view to the application of some of their peculiar features to the purposes of instruction in his own country. The character of this distinguished professor, and his known admiration of American institutions, secured for this request the prompt and liberal response of several publishers, a list of whom, with the number of works contributed, is as follows:

	Volumes.
Harper & Brothers, New York.....	62
A. S. Barnes & Co., New York.....	26
Oakley & Mason, New York.....	10
C. Scribner, New York.....	3



	Volumes.
H. Cowperthwaite & Co., Philadelphia .....	10
U. Hunt & Son, Philadelphia.....	12
E. C. & J. Biddle, Philadelphia .....	12
A. S. Davis & Co., Boston.....	6
Sargent, Wilson & Hinckle, Cincinnati .....	33

Professor Laboulaye, in acknowledging the receipt of these 174 volumes, says: "These books form the admiration of all who take an interest in education, and I hope that France will profit by this example. We have excellent things at home by which you in turn might profit, but we have seen nothing comparable to your readers, your object lessons, your graphics, and your geographical series."

The Institution in like manner frequently received applications from foreign governments and societies for official publications of the States, of general government, relative to certain branches of political economy, statistics, education, &c. During the year 1868 a request of this kind was received from the Belgian Government for all the publications of the States in regard to public schools.

In answer to a circular asking for these documents, a large and valuable collection was received, for which the thanks of the Institution were returned to the following persons: A. Rogers, second auditor of Virginia; T. Jordan, secretary of state, Pennsylvania; S. C. Jackson, assitant secretary board of education, Massachusetts; J. A. Morris, school commissioner, Ohio; N. Bateman, superintendent of education, Illinois; C. J. Hoadley, state librarian, Connecticut; F. Rodman, secretary of state, Missouri; R. A. Barker, secretary of state, Kansas; Ed. Wright, secretary of state, Iowa; C. W. Wright, secretary of state, Delaware; J. E. Tenney, secretary of state, Michigan, and the secretary of state, Wisconsin.

Another application of a similar character was received from the Government of Norway for the publications of the United States relative to military affairs, which, on being referred to the heads of departments and bureaus, secured a large number of the desired publications. Acknowledgments for these favors were made to General E. D. Townsend, Adjutant-General; General A. A. Humphreys, Chief Engineer, United States Army; Surgeon-General Barnes; Paymaster-General Brice; General Dyer, Chief of Ordnance; Commodore Jenkins, Chief of Bureau of Ordnance and Hydrography, Navy Department; General Myer, Chief Signal Officer.

For official co-operation with the Institution in its plans for the promotion of knowledge, and important assistance rendered, besides the foregoing, may be mentioned Hon. William H. Seward, Secretary of State; Hon. Hugh McCullough, Secretary of the Treasury; Hon. Horace Capron, Commissioner of Agriculture; General Meigs, Quartermaster-General; Mr. Spofford, Librarian of Congress; Professor J. H. C. Coffin, Superintendent of the Nautical Almanac, and Commodore Sands, of the National Observatory.

Most valuable assistance in connection with foreign exchanges was also rendered by E. J. Davison, Argentine consul; José I. Sanchez, consul of Venezuela; B. Blanco, consul-general of Guatemala; L. H. J. D'Aguir, consul-general of Brazil; R. C. Burlage, consul-general of Netherlands; Hon. E. Juteirez, minister from Costa Rica; the American Board of Commissioners of Foreign Missions; Real Sociedad Economica, Havana; Board of Foreign Missions, New York; American Colonization Society, Washington; Society of Geography and Statistics, Mexico; University of Chili; Bataviaasche Genootschap van Kunsten en Wetenschappen, Java; and the Institute of History, Geography, and Ethnology, of Rio Janeiro.

It was not alone from societies or public bodies that works were received by the Institution for gratuitous distribution at home and abroad among libraries or establishments of learning where they might obtain appreciation. Copies of works produced by private enterprise were not infrequently sent to the Institution by individuals who could not afford the additional expense attendant upon their desired transmission to distant and scattered points.

In most cases the list of distribution was made out by the parties sending the copies, but sometimes the selection of recipients was left to the Institution.

Among the articles distributed in this way was the narrative of an exploration to Musardo, the capital of the western Mandigoes, through the country east of Liberia, by Benjamin Anderson, a young man of pure negro blood. The narrative was printed without correction from the original manuscript, at the expense of Mr. H. M. Schieffelin, of New York, and nearly the whole of the edition was presented to the Institution for distribution.

#### LIBERALITY OF TRANSPORTATION COMPANIES.

The rapid extension of the Smithsonian exchanges soon became a heavy tax upon the resources of the Institution; and the conduct of its principal function ("the increase of knowledge among men" by the promotion of original research and discovery) was threatened with being crippled and overridden by the demands of a service really held as incidental and subordinate thereto. With a view to diminish, if possible, the expenses involved, the Institution, in 1855, addressed several of the leading transatlantic steamship companies, unfolding its methods, and asking, in consideration of the great public benefit of the system, the favor of reduced rates of freight upon this particular service.

With a liberality and public spirit which cannot be too highly admired, the companies addressed agreed to carry the freights of the Smithsonian Institution not merely at an abatement, but without charge; and thus generously enabled the Institution to maintain the growing magnitude of the operations, when otherwise the system must have broken down by its own weight.

At a meeting of the Board of Regents, on the 8th of March, 1856, it was—

*Resolved*, That the Secretary, on the part of the Regents of the Smithsonian Institution, return thanks to the United States Mail Steamship Company, M. O. Roberts, president; Pacific Mail Steamship Company, W. H. Aspinwall, president; South American Mail Steamship Company, Juan Matteson, president; Mexican Gulf Steamship Company, Harris & Morgan, agents; and the Panama Railroad Company, David Hoadley, president, for their liberality and generous offices in relation to the transportation without charge of articles connected with the operations of the Institution.

In the Secretary's report for 1867, he says: "The system has now attained a great development and increases measurably every year. The expenses hitherto have been principally borne by the Institution, but their amount has now become so great as seriously to interfere with other operations. . . . The expenses of the Smithsonian exchanges would be considerably greater than they are, but for the liberality of various transportation companies in carrying packages free of cost."

The line of sailing vessels between New York and the west coast of South America, belonging to Mr. Bartlett, 110 Wall street, also engaged to carry all the Chilean exchanges free of charge.

In the course of the year 1858, Hon. R. Schleiden, the minister from Bremen, offered his service in trying to procure for the Smithsonian Institution the advantage of free or reduced freight on exchanges for the port of Bremen. His success is announced in the following letter:

Bremen Legation, Washington, January 25, 1859.

Prof. JOSEPH HENRY,

*Secretary of the Smithsonian Institution:*

SIR: Agreeably to your verbal request, I have proposed to the president and directors of the North German Lloyd of Bremen to manifest their interest in the cause of science by facilitating literary intercourse between the United States and Germany, by means of their steamers plying between Bremen and New York.

It affords me great pleasure now to inform you that, according to a letter of the president of the Lloyd, dated the 5th instant, and just received, the said Bremen Steamship Company have resolved, henceforth and until further notice, to forward by their steamers all the packages of books and specimens of natural history which the Smithsonian Institution may be pleased to send to Germany, or which may be sent from Germany to the Smithsonian Institution, free of charges between New York and Bremerhaven.

I beg leave to add that Messrs Gelpcke, Keutgen, and Reichelt, 84 Broadway, New York, are the agents of the North German Lloyd at that place, and that the next Bremen steamer sailing for Europe will leave New York on the 19th of February next.

I avail myself of this occasion to offer you renewed assurances of my high consideration.

R. SCHLEIDEN,  
*Minister Resident of Bremen.*

The following resolution was adopted by the Board of Regents, February 15, 1859:

*Resolved*, That the thanks of this board be returned to his excellency R. Schleiden, minister resident of Bremen, for his intervention with the "North German Lloyd of Bremen," to facilitate and advance the cause of science by transporting, free of charge, &c., packages of books and specimens of natural history from Germany to the Smithsonian Institution, and from the Institution to Germany, and the like thanks to the president and directors of the North German Lloyd of Bremen for their generous liberality in the instance above referred to.

On the 16th of February, 1860, Professor Henry addressed a letter to Mr. Edward Cunard, of the steamship line running between New York and Liverpool, asking similar favors, in reply to which the following letter was received, which was laid before the Board of Regents at their meeting on March 17, 1860:

New York, February 25, 1860.

Prof. JOSEPH HENRY,  
*Secretary of the Smithsonian Institution:*

DEAR SIR: I have to acknowledge the receipt of your letter of the 16th instant, and, in reply, I beg to inform you that I shall have much pleasure in conveying in our steamers from New York to Liverpool, every fortnight, one or more cases from the Smithsonian Institution to the extent of half a ton or 20 cubic feet measurement. The cases to be addressed to your agent in Liverpool, or to his care. The arrangement of free cases is intended only to apply to those shipped by you from this side of the water.

Your obedient servant,  
E. CUNARD.

At a meeting of the Regents, held April 7, 1860, it was—

*Resolved*, That the thanks of the Board of Regents are hereby given to the various companies and individuals who have generously aided in advancing the objects of the Smithsonian Institution and the promotion of science, by the facilities they have afforded in the transportation of books, specimens, &c., free of charge.

In the next year, 1861, in response to an application by Professor Henry, another concession of free freight was granted by the Hamburg American Packet Company, in the following communication:

Hamburg American Packet Company,  
New York, October 21, 1861.

Prof. J. HENRY,

*Secretary Smithsonian Institution:*

DEAR SIR: In reply to your favor of October 18, we beg to state that we shall be most happy to accommodate the Smithsonian Institution in furthering the wishes you express, and take on freight, free of charge, any packages which you desire to ship, be they specimens of natural history, books, or other articles desired to be forwarded to Germany or the continent of Europe, irrespective of bulk.

Very respectfully, yours,  
KUNHARDT & Co.

At a meeting of the Board of Regents held May 1, 1862, it was—

*Resolved*, That the thanks of the Board of Regents be presented to the Hamburg American Packet Company for their liberal co-operation in assisting to advance the objects of this institution.

Without detailing the successive acquiescence of different companies it is sufficient to mention that the following great transportation lines now grant free freight to the Smithsonian packages:

Anchor Steamship Company (Henderson & Bros., agents), New York.

Atlas Steamship Company (Pim, Forwood & Co., agents), New York.

Bland (Thomas), New York.

Cameron (R. W. & Co.), New York.

Compagnie Générale Transatlantique (L. De Bébien, agent), New York.

Cunard Royal Mail Steamship line (Vernon Brown & Co., agents), New York.

Dallett, Boulton & Co., New York.

Denison (Thomas), New York.

Hamburg American Packet Company (Kunhardt & Co., agents), New York.

Netherlands American Steam Navigation Company (H. Oazeaux, agent), New York.

North German Lloyd Steamship Company (agents, Oelrichs & Co., New York; Schumacher & Co., Baltimore).

Pacific Mail Steamship Company, New York.

Red Star Line (Peter Wright & Sons, agents), New York.

White Cross Line (Funch, Edye & Co., agents), New York.

#### FOREIGN AGENCIES.

In the special work of foreign distribution of memoirs and packages sent abroad, the establishment of various agencies in the principal capitals, of course, became necessary. The same agencies were also em-

ployed as centers for the collection of publications designed to be sent to the Institution. In the Smithsonian report for 1878 it was announced that—

“Of late years in certain countries these labors have been materially lightened by a portion of the exchange being undertaken by some learned society, or by the government. These, being constituted Smithsonian agents in their respective countries, receive whatever may be sent them for distribution, collect the returns and transmit them, thus giving to the Institution the benefit of an intelligent superintendence of the work. The first of these organizations was that established some years ago by the University of Christiania, Norway, and by Holland in the patronage of the Scientific Bureau at Harlem under the efficient supervision of Dr. E. H. Von Baumhauer. During the past year a similar organization has been effected for Belgium, and it is hoped that their number will continue to increase. Even now, without any formal arrangement to that effect, the Academies of Science of Stockholm, of Copenhagen, of Madrid, and of Milan, discharge the services of agents of the Institution for their respective countries.”

*Present List of Foreign Centers of Distribution.*

- Argentine Republic.*—Museo Publico, Buenos Ayres.  
*Austria-Hungary.*—Dr. Felix Flügel, Leipsic.  
*Bavaria.*—Dr. Felix Flügel, Leipsic.  
*Belgium.*—Commission Belge des Échanges Internationaux, Brussels.  
*Brazil.*—Commission of International Exchange, Rio Janeiro.  
*British Guiana.*—Observatory, Georgetown.  
*Canada.*—McGill College, Montreal; Geological Survey of Canada, Ottawa.  
*Cape Colonies.*—William Wesley, London, England.  
*Chili.*—Universidad, Santiago.  
*China.*—United States consul-general, Shanghai.  
*Costa Rica.*—Universidad, San José.  
*Denmark.*—K. D. Videnskabernes Selskab, Copenhagen.  
*Dutch Guiana.*—Koloniale Bibliotheek, Surinam.  
*East Indies.*—William Wesley, London, England.  
*Ecuador.*—Observatorio, Quito.  
*Egypt.*—Institut Egyptien, Cairo.  
*Finland.*—F. A. Brockhaus, Leipsic, Germany.  
*France.*—Commission Française des Échanges Internationaux, Paris.  
*Germany.*—Dr. Felix Flügel, Leipsic.  
*Great Britain.*—William Wesley, London.  
*Greece.*—Bibliothèque Nationale, Athens.  
*Guatemala.*—Sociedad Economica de Amigos del Pais, Guatemala.  
*Hayti.*—Secrétaire d'État des Relations Extérieures, Port-au-Prince.  
*Iceland.*—Islands Stiptisbokasafn, Reykjavik.  
*Italy.*—Biblioteca Nazionale Vittorio Emanuele, Rome.

- Japan*.—Minister of Foreign Affairs, Tokio.  
*Liberia*.—Liberia College, Monrovia.  
*Mexico*.—Museo Nacional, Mexico.  
*Netherlands*.—Bureau Scientifique Néerlandais, Harlem.  
*Nederlandsch India*.—Genootschap van Kunsten en Wetenschappen, Batavia, Java.  
*New Caledonia*.—Gordon and Gotch, London, England.  
*New South Wales*.—Royal Society of New South Wales, Sydney.  
*New Zealand*.—Colonial Museum, Wellington.  
*Norway*.—K. N. Frederiks Universitet, Christiania.  
*Philippine Islands*.—Royal Economical Society, Manila.  
*Polynesia*.—Royal Hawaiian Agricultural Society, Honolulu.  
*Portugal*.—Escola Polytechnica, Lisbon.  
*Prussia*.—Dr. Felix Flügel, Leipsic.  
*Queensland*.—Government Meteorological Observatory, Brisbane.  
*Russia*.—Commission Russe des Échanges Internationaux, St. Pétersburg.—(Imperial Public Library.)  
*Saxony*.—Dr. Felix Flügel, Leipsic.  
*St. Helena*.—William Wesley, London, England.  
*South Australia*.—Astronomical Observatory, Adelaide.  
*Spain*.—Real Academia de Ciencias, Madrid.  
*Strait Settlements*.—William Wesley, London, England.  
*Sweden*.—K. S. Vetenskaps Akademien, Stockholm.  
*Switzerland*.—Eidgenossensche Bundeskanzlei, Berne.  
*Tasmania*.—Royal Society of Tasmania, Hobarton.  
*Trinidad*.—Scientific Association, Port of Spain.  
*Turk's Island*.—Public Library, Grand Turk.  
*United States of Colombia*.—Central Office of Exchanges, National Library, Bogotá.  
*Venezuela*.—University, Caracas.  
*Victoria*.—Public Library, Melbourne.  
*Württemberg*.—Dr. Felix Flügel, Leipsic.

#### AMOUNT AND COST OF EXCHANGES.

The tabular statement subjoined of the yearly amount of matter sent abroad by the Institution from the commencement of its operations to the end of the last year, 1881, will show the progress, extent, and condition of its foreign exchanges. It may be stated in brief that during the first ten years of the system (closing with 1860) the total weight of matter sent abroad amounted to 145,979 pounds, the cost of the same to the Institution being \$22,989.29; the weight sent during the second decade (closing with 1870) was 221,713 pounds, at a cost of \$32,398.84; and that the weight sent during the third decade (closing with 1880) was 570,571 pounds, at a cost of \$78,453.01.

Notwithstanding the remarkable liberality with which the exertions of the Institution have been aided by the great transportation compa-

pies at home and abroad, the co-operation of learned societies, and the remission of duties and custom-house expenses by all nations, the actual cost of these international exchanges to the Smithsonian fund has reached for the last five or six years to fully one-fourth of its entire income.

*Cost of exchanges to the Institution.*

1846-1850.....	\$1,603 00	1867.....	\$3,701 93
1851.....	2,010 49	1868.....	4,870 72
1852.....	2,178 33	1869.....	4,860 94
1853.....	2,807 38	1870.....	4,165 62
1854.....	2,738 65	1871.....	4,201 50
1855.....	1,930 78	1872.....	5,870 32
1856.....	1,517 54	1873.....	6,251 74
1857.....	2,500 24	1874.....	5,589 89
1858.....	1,326 90	1875.....	6,748 80
1859.....	2,027 94	1876.....	10,199 10
1860.....	2,348 04	1877.....	9,790 73
1861.....	1,499 47	1878.....	10,250 41
1862.....	2,724 88	1879.....	9,554 47
1863.....	1,735 31	1880.....	9,996 05
1864.....	3,779 61	1881.....	*7,467 84
1865.....	2,807 76		
1866.....	2,252 60	Total.....	\$141,308 98

*Shipments of foreign-exchanges.—No. of boxes from 1850 to 1881.*

	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	1858.	1859.	1860.	1861.	1862.	1863.	1864.	1865.	1866.
Africa.....			1														
America:																	
British America.....																	
Central America and West Indies.....																	
Mexico.....			1														
South America.....			1	2	1												
Asia.....			1														
Australasia.....																1	1
Europe:																	
Belgium.....	1	1	1	2	1		2	1	1	1	1	1	2	1	1	2	1
Denmark (including Iceland).....	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1
France.....	6	6	5	6	5	4	8	4	6	10	10	4	13	9	8	10	9
Germany (including Austria-Hungary).....	10	11	12	12	11	12	27	11	21	17	12	18	24	17	17	24	20
Great Britain.....	19	11	11	11	8	5	9	10	17	25	22	6	16	14	13	9	11
Greece.....																	
Italy.....	3	3	3	3	2	2	4	2	4	4	3	2	6	3	3	3	4
Netherlands.....	1	1	2	2	1	1	3	1	1	3	1	3	5	4	2	1	1
Norway.....			1	1	1	1	1	1	1	1	1	1	1		1	1	1
Russia.....	1	1	1	3	2	1	5	2	1	5	2	3	6	4	2	4	3
Spain and Portugal.....	1	1	1		1		1	1	1	1		1	1	1	1	2	2
Sweden.....	1	1	1	1	1	1	1	1	1	1	1	2	2	1	1	1	1
Switzerland.....	2	2	1	2	1	1	2	1	1	3	2	1	4	2	3	3	3
Turkey.....																	
Polynesia.....																	
Rest of the world.....	1	2		2	2	4	6	5		10	5	30	32	4	10	12	22
	40	40	46	48	38	33	70	40	56	82	68	73	114	61	63	77	83

\*The apparent reduction of expense for the last year (1881) is due to an appropriation of \$3,000 allowed by Congress in aid of the government exchanges. It thus appears that the average expense of the international exchanges for the last six years has exceeded \$10,000 per annum.



*Shipments of foreign exchanges—No. of boxes from 1850 to 1881—Continued.*

	1867.	1868.	1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	Total.
Africa.....						3	2	2			2			1		11
America:																
British America.....								9	3	2	5	4	2	1	10	36
Central America and West Indies.....							2	2	1	8	9	2	14	4	6	48
Mexico.....									7	3	5	4	5	6	9	40
South America.....							8	5	21	20	25	16	20	13	28	180
Asia.....						48		5	1	3	11	4	3	4	9	84
Australasia.....			4		2	2		11		49	33	20	14	26	23	186
Europe:																
Belgium.....	2	2	2	2	2	4	7	5	10	7	6	8	6	9	8	100
Denmark (including Iceland). ..	2	2	3	3	2	3	4	4	3	5	5	6	14	8	6	88
France.....	7	14	7	11	6	8	18	11	24	23	32	42	40	26	36	428
Germany (including Austria-Hungary). ..	38	26	35	37	28	40	59	36	39	62	95	77	77	54	80	1,060
Great Britain.....	24	23	16	20	23	27	36	30	43	64	71	58	52	52	54	802
Greece.....				1	1	1	2	1	1	1	7	2	3	1	2	32
Italy.....	5	5	3	8	8	5	10	3	8	11	20	10	13	5	46	214
Netherlands.....	8	4	4	4	1	4	10	5	4	7	13	8	8	11	14	144
Norway.....	1	2	1	2	2	3	8	3	2	8	9	6	4	4	9	78
Russia.....	6	6	4	8	4	6	10	7	9	13	16	9	10	12	27	203
Spain and Portugal.....	1	1	2	2	2	2	10		10	10	24	10	8	10	10	117
Sweden.....	2	2	2	3	3	4	4	5	10	13	9	8	8	10	10	112
Switzerland.....	2	4	3	5	2	4	6	5	6	13	6	14	8	7	8	127
Turkey.....									6	1	2	1	2	1	2	15
Polynesia.....											1			3		4
Rest of the world.....	15	14	26	15	23	20										269
	113	104	112	121	106	179	196	149	208	323	406	309	311	268	407	4,339

*Shipments of foreign exchanges—whole quantity from 1850 to 1881.*

Year.	Number of boxes.	Bulk in cubicfeet.	Weight in pounds.	Year.	Number of boxes.	Bulk in cubicfeet.	Weight in pounds.
1850.....	40	200	6,900	1867.....	113	975	22,523
1851.....	40	240	7,920	1868.....	104	1,057	31,171
1852.....	46	263	9,885	1869.....	112	1,053	23,376
1853.....	48	392	12,200	1870.....	131	1,198	31,323
1854.....	58	365	9,791	1871.....	108	772	28,650
1855.....	53	358	10,431	1872.....	179	954	28,850
1856.....	70	586	18,371	1873.....	196	1,476	44,236
1857.....	40	384	14,248	1874.....	149	1,933	27,990
1858.....	56	672	22,674	1875.....	268	1,503	45,309
1859.....	82	1,054	29,480	1876.....	323	2,261	50,750
1860.....	61	767	20,029	1877.....	406	3,276	117,090
1861.....	73	625	16,958	1878.....	309	2,160	60,229
1862.....	114	1,006	22,896	1879.....	311	2,177	60,975
1863.....	61	447	10,286	1880.....	268	1,976	60,900
1864.....	63	546	20,500	1881.....	407	2,800	100,750
1865.....	77	557	18,630				
1866.....	83	571	18,050	Total.....	4,339	33,575	1,054,913

## II.—DOMESTIC EXCHANGES.

The system of domestic exchanges embraces not only the distribution of Smithsonian and other American contributions to knowledge throughout our country, but that of the publications received from foreign countries as well, intended for societies and individuals here. By the liberal courtesy of many well-established houses in the book business in different parts of the country, these domestic transmissions were effected with a very satisfactory dispatch and fidelity. The gentlemen to whom the Institution was mainly indebted in 1851 and the immediately

following years for this valuable service were Messrs. J. P. Jewett & Co., of Boston; George P. Putnam, of New York; Lippincott, Grambo & Co., of Philadelphia; John Russell, of Charleston; and H. W. Derby, of Cincinnati. To these names should be added in 1852 and following years those of Messrs. Jewett, Proctor, and Worthington, of Cleveland; Dr. George Engelmann, and John Halsall, of Saint Louis; and B. M. Norman, of New Orleans.

As an incidental but striking illustration of the interest awakened in the international exchange at that early day may be mentioned, among the numerous literary gifts to the Institution, a rare and curious collection of manuscripts of very varied character, sufficiently described in the following letter of presentation:

"Avenue Lodge, Brixton Hills, near London,

"October 28, 1852.

"Prof. JOSEPH HENRY:

"SIR: I have the pleasure of offering for your acceptance for the use of the Smithsonian Institution a collection of documents formed for the purpose of illustrating the history of prices between the years 1650 and 1750. The collection, regarded as a collection, is, I believe, unique in its kind, although many manuscripts of the same description are to be found dispersed amongst the vast stores of the British Museum and other libraries in this country. It consists of about seven thousand original papers bound in fifty-four volumes, including bills, accounts, and inventories respecting commercial and domestic articles of nearly every description.

"It will afford me great pleasure if the allocation of these papers at Washington prove of use at any time to the literary inquiries of your great nation. Without incurring the imputation of falling into the ordinary error made by collectors in attaching a fictitious value to relics which have necessarily required the expenditure of considerable time and exertion to bring together, it may, perhaps, be allowed me to entertain a hope that these fragments of an earlier age, now confided to your care, may be hereafter regarded of importance in the list of materials which will some day assist in producing a history of social progress.

"Mr. Henry Stevens, F. S. A., the agent to the Smithsonian Institution in England, has kindly undertaken to forward the collection to you on an early opportunity.

"I feel sure you will excuse the liberty I am taking in addressing you on this subject; and I have the honor to be, sir,

"Your obedient, faithful servant,

"J. O. HALLIWELL."

The history and condition of domestic exchanges, from their commencement to the present time, are exhibited in the following tables:

Year.	Received for the Smithsonian library.				For other institutions in the United States.	
	Volumes.	Parts and pamphlets.	Maps and engravings.	Total.	Addresses.	Packages.
1846 to 1850 .....	470	624	4	1,098	.....	.....
1851 .....	549	618	.....	1,167	.....	.....
1852 .....	1,481	2,106	1,749	5,336	06	637
1853 .....	1,440	991	125	2,556	160	1,052
1854 .....	926	1,468	434	2,828	149	967
1855 .....	1,037	1,707	26	2,770	219	1,445
1856 .....	1,356	1,834	140	3,330	189	1,245
1857 .....	555	1,067	138	1,760	193	1,273
1858 .....	733	1,065	122	2,920	243	1,530
1859 .....	1,022	2,540	40	3,602	298	1,303
1860 .....	1,271	4,180	290	5,671	335	1,908
1861 .....	831	1,945	120	2,896	274	1,406
1862 .....	1,611	3,369	55	5,035	273	2,111
1863 .....	910	3,479	200	4,589	373	1,522
1864 .....	823	2,754	109	3,686	299	2,482
1865 .....	767	3,256	183	4,206	345	2,368
1866 .....	1,243	4,509	121	5,873	329	2,703
1867 .....	1,537	3,946	328	5,811	347	971
1868 .....	1,770	3,605	134	5,509	436	2,394
1869 .....	1,234	4,089	223	5,555	501	4,130
1870 .....	1,113	3,890	179	5,182	567	3,705
1871 .....	966	3,579	82	4,597	673	3,952
1872 .....	1,262	4,502	198	5,962	587	4,635
1873 .....	889	4,354	454	5,697	689	4,782
1874 .....	863	4,521	162	5,546	750	4,336
1875 .....	1,120	5,813	114	7,047	610	4,661
1876 .....	1,017	6,193	375	7,585	644	4,853
1877 .....	1,889	6,511	320	8,726	766	4,962
1878 .....	1,963	7,392	74	9,429	662	5,292
1879 .....	1,949	8,071	183	10,203	735	6,971
1880 .....	1,143	7,275	152	8,570	945	5,587
1881 .....	1,867	9,904	188	11,959	1,054	8,433
Total .....	33,877	99,787	6,966	165,631	13,286	94,765

*Distribution of domestic exchanges, showing number of packages received for societies, &c., in the United States and British America from 1852-1881.*

ALABAMA.		Little Rock :	
Mobile :		Governor of the State .....	39
Barten Academy .....	1	Institution for Deaf and Dumb .....	2
University of Mobile .....	1	Educating the Blind .....	1
Montgomery :		Literary Institution .....	2
State Library .....	22	State Geologist .....	1
Talladega :		Institute .....	1
Institution for Deaf and Dumb .....	2	Library .....	340
Tuscaloosa :		University .....	22
Alabama University .....	11		
Geological Survey .....	5		
Hospital for the Insane .....	2		
ARIZONA.		CALIFORNIA.	
Prescott :		Berkeley :	
Territorial Library .....	6	University of California .....	5
		Marysville :	
		Marysville Library .....	1
		Oakland :	
		Health Office .....	2
Fayetteville :		Institution for the Deaf and Dumb .....	1
Industrial University .....	1	University of California .....	27
Holly Grove :			
Literary Institute .....	6	Sacramento :	
Judsonia :		Agricultural and Horticultural Society .....	7
Judson University .....	1		

*Distribution of domestic exchanges, &c.—Continued.***Sacramento—Continued.**

California Institution.....	2
Free Library.....	1
Geological Survey of California.....	3
Institution for the Deaf, Dumb, and Blind.....	1
Medical Society of California.....	1
State Agricultural Society.....	16
Library.....	17

**San Francisco:**

Academy of Sciences.....	1,295
Agricultural Society.....	1
and Horticultural Society.....	2
Bibliothèque de la Ligne.....	1
Board of Health.....	2
California Historical Society.....	4
Corporation of the city.....	1
Geological Society.....	3
Survey.....	28
Governor of State.....	3
Institution for Deaf and Dumb.....	4
Library of San Francisco.....	1
Lick Observatory.....	7
Mayor of the city.....	7
Mechanics' Institute.....	2
Mercantile Library Association.....	13
Microscopical Society.....	1
Municipality.....	1
Observatory.....	1
Odd Fellows' Library.....	1
Office of James Lick Institute.....	1
Pharmaceutical Association.....	1
Society for Protection of Ani- mals.....	1
St. Ignatius College.....	1
State Horticultural Society.....	1

**Santa Clara:**

Santa Clara College.....	1
University of the Pacific.....	1

**Stockton:**

Society of Natural History.....	6
State Lunatic Hospital.....	12

**COLORADO.****Central City:**

Miners and Mechanics' Institute.....	3
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**Colorado Springs:**

El Paso County Library Asso- ciation.....	1
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**Denver:**

Agricultural Society.....	1
Governor of Colorado.....	4
State Library.....	2
Territorial Library.....	4

**CONNECTICUT.****Bridgeport:**

Bridgeport Library and Reading Room.....	1
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**Hartford:**

American Philological Associa- tion.....	2
Philosophical Society.....	1
Board of Agriculture.....	12
Hartford Society of Science.....	4
Historical Society of Connecti- cut.....	20

**Hartford—Continued.**

Hospital for the Insane.....	2
Institution for the Deaf and Dumb.....	4
Murphy Philosophical Associa- tion.....	1
Physical Society.....	1
Retreat for the Insane.....	7
Society of Natural History.....	2
Science.....	1
Physical Science.....	1
State Agricultural Society.....	9
Library.....	4
Theological Institute.....	1
Trinity College.....	16
Watkinson and Connecticut Historical Society.....	1
Watkinson Library of Refer- ence.....	2
Young Men's Christian Associa- tion.....	8
Institute.....	29

**Litchfield:**

Retreat for the Insane.....	1
Springfield Institute.....	1

**Middletown:**

Connecticut State Hospital for the Insane.....	3
Wesleyan University.....	13

**New Britain:**

State Normal School.....	1
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**New Haven:**

American Journal of Arts and Sciences.....	1,158
Oriental Society.....	511
Connecticut Academy of Sci- ences.....	1,197
Mercantile Library.....	1
New Haven Museum.....	1
Peabody Museum.....	1
Sheffield Scientific School.....	18
State Board of Agriculture.....	2
Yale College.....	415
Museum.....	1
Observatory.....	3
Young Men's Institute.....	2

**New London:**

Young Men's Christian Associa- tion.....	1
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**Norwich:**

Otis Library.....	1
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**Waterbury:**

Bronson Library.....	1
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**DELAWARE.****Dover:**

State Library.....	3
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**Newark:**

Delaware College.....	1
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**Wilmington:**

Agricultural Society.....	3
Wilmington Institute.....	2

**DISTRICT OF COLUMBIA.****Georgetown:**

Georgetown College.....	234
Observatory of Georgetown Col- lege.....	8

*Distribution of domestic exchanges, &c.—Continued.*

<i>Hilledale:</i>	
Pioneer Sunday School .....	1
<i>Washington:</i>	
Agricultural Department .....	1,695
American Annals of the Deaf and Dumb .....	2
Medical Association .....	195
Museum .....	23
Anthropological Society .....	5
Belgian Legation .....	5
Board of Health .....	8
Botanic Garden .....	2
Bureau of Ethnology .....	3
Census Bureau .....	100
Chinese Legation .....	15
Coast Survey .....	1,585
Columbia Hospital for Women. University .....	22
Commissioners of the District.	1
Construction and Repair Bu- reau, United States Navy .....	2
Clinico Pathological Society .....	1
Corcoran Art Gallery .....	1
Corporation of the city .....	1
Corps of Topographical Engi- neers .....	1
Cosmos Club .....	1
Education, Bureau of .....	102
Engineer Bureau, United States Army .....	106
Entomological Commission .....	6
Geographical Surveys .....	14
Geological Surveys of the Ter- ritories .....	600
German Reading and Chess Club .....	1
Relief Association .....	28
Governor of the District .....	2
Government Hospital for the Insane .....	7
Howard University .....	4
Hydrographic Office .....	126
Index Medicus .....	3
Indian Bureau .....	24
Commissioners .....	14
Interior Department .....	90
Land Office .....	83
Library of Congress .....	619
Light-House Board .....	8
Marine Hospital .....	4
Medical Society of the District of Columbia .....	10
Medicine and Surgery, Bureau of .....	3
Mint, Bureau of .....	16
National Academy of Sciences .....	942
Deaf-Mute College .....	20
Institute .....	39
Museum .....	36
Nautical Almanac .....	119
Naval Observatory .....	1,898
Navigation, Bureau of .....	68
Navy Department .....	52
Ordnance Bureau, United States Army .....	122
Odd Fellows' Library .....	1
Patent Office .....	3,391

*Washington—Continued.*

Paymaster Department, United States Navy .....	1
Pharmaceutical Association .....	4
Philosophical Society .....	33
President of the United States .....	15
Provost-Marshal General .....	4
Public Schools .....	26
Quartermaster-General's Office .....	2
Revenue Department .....	2
Signal Office, United States Army .....	286
Spencerian Business College .....	1
State Department .....	82
Statistics, Bureau of .....	186
Surgeon-General's Office, U.S.A. Hospital .....	2,072
Swedish and Norwegian Lega- tion .....	5
Survey of North-American Lakes .....	3
Territorial Legation .....	1
Topographical Bureau .....	3
Treasury Department .....	54
Trigonometrical Survey .....	2
U. S. Agricultural Society .....	1
and Mexican Boundary Survey .....	3
Fish Commission .....	14
Naval Expedition to Chili .....	34
War Department .....	103
Washington Sentinel .....	1

## FLORIDA.

<i>Jacksonville:</i>	
Young Men's Christian Associa- tion .....	3
<i>Saint Augustine:</i>	
Historical Society of Florida .....	4
<i>Tallahassee:</i>	
Academy of Tallahassee .....	2
Public Library .....	1

## GEORGIA.

<i>Athens:</i>	
Hospital for the Insane .....	1
State Agricultural College .....	1
University of Athens .....	4
<i>Atlanta:</i>	
Agricultural Department and State Agricultural Society .....	1
City Library .....	3
Medical College .....	1
and Surgical Journal .....	2
University .....	2
<i>Augusta:</i>	
Horticultural Society .....	1
Medical College .....	1
<i>Cave Spring:</i>	
Institution for the Deaf and Dumb .....	4
<i>Macon:</i>	
Public Library and Historical Society .....	1
<i>Milledgeville:</i>	
Hospital for the Insane .....	3

*Distribution of domestic exchanges, &c.—Continued.*

<i>Milledgeville—Continued.</i>		<i>Jacksonville:</i>	
Oglethorpe University.....	29	Illinois College.....	2
State Library.....	19	Institution for the Deaf and	
University.....	4	Dumb.....	4
<i>Oxford:</i>		State Hospital for the Insane..	11
Emory College.....	1	Institution for the Blind.....	9
<i>Pennfield:</i>		<i>Lebanon:</i>	
Mercer University.....	1	McKendrick College.....	1
<i>Savannah:</i>		<i>Monmouth:</i>	
Chatham Academy.....	1	Monmouth College.....	1
Historical Society.....	36	Warren County Library.....	1
IDAHO.		<i>Moro:</i>	
<i>Boise City:</i>		American Pomological Society..	8
Territorial Agricultural Society	3	Mercantile Library Association	8
ILLINOIS.		<i>Normal:</i>	
<i>Abingdon:</i>		Illinois Museum of Natural His-	
Abingdon College.....	1	tory.....	10
<i>Aurora:</i>		State Laboratory of Natural	
Literary and Historical Society	1	History.....	1
<i>Bloomington:</i>		Natural History Society.....	19
Illinois Museum of Natural His-		"The Schoolmaster".....	2
tory.....	16	<i>Ottawa:</i>	
Natural History Society.....	2	Ottawa Academy of Natural	
Library.....	1	Sciences.....	6
Wesleyan University.....	1	<i>Peoria:</i>	
<i>Carbondale:</i>		Mercantile Library Association	8
Southern Illinois Normal Uni-		<i>Rantone:</i>	
versity.....	15	Literary Society.....	5
<i>Champaign:</i>		<i>Rock Island:</i>	
Industrial University.....	2	Augustana College.....	2
<i>Chicago:</i>		Public Library.....	1
Academy of Sciences.....	1,191	<i>Springfield:</i>	
American Electrical Society...	1	Academy of Music.....	2
Astronomical Observatory.....	3	Geological Survey.....	8
Society.....	9	Library Association.....	1
Board of Trade.....	13	St. Joseph's College.....	1
Botanic Garden.....	1	State Agricultural College.....	14
Chicago Historical Society.....	6	Board of Agriculture....	4
Medical Journal.....	2	Library.....	23
Times.....	11	University.....	1
Free Library.....	5	<i>Vandalia:</i>	
Historical Association.....	4	Historical and Archæological	
Illinois Staats Zeitung.....	1	Society.....	4
Insane Asylum.....	1	<i>Westfield:</i>	
Mayor of the city.....	6	Westfield College.....	1
Mechanics' Institute.....	27	<i>Wheaton:</i>	
Museum of Natural History...	4	Wheaton College.....	1
National Live Stock Journal..	1	INDIANA.	
Observatory.....	7	<i>Bloomington:</i>	
Public Library.....	63	Indiana University.....	8
School Library.....	30	<i>Crawfordsville:</i>	
Rush Medical College.....	1	Wabash College.....	1
Society of Natural History....	2	<i>Fort Wayne:</i>	
State Microscopical Society...	3	Concordia College.....	2
Theological Seminary.....	1	<i>Greencastle:</i>	
University.....	8	Asbury University.....	9
Young Men's Association Li-		<i>Hanover:</i>	
brary.....	6	Hanover College.....	1
<i>Elgin:</i>		<i>Indianapolis:</i>	
Hospital for the Insane.....	3	Academy of Sciences.....	10
North Illinois Hospital.....	1	Bureau of Statistics and Geol-	
<i>Evanston:</i>		ogy.....	2
Northwestern University.....	10	Geological Society.....	1
<i>Galesburg:</i>		Survey of Indiana..	74
Academy of Music.....	1	Horticultural Society.....	3
Knox College.....	1	Hospital for the Insane.....	3
Lombard University.....	13	Indiana Historical Society....	23

*Distribution of domestic exchanges, &c.—Continued.*

<b>Indianapolis—Continued.</b>			
Institution for Deaf and Dumb.	10		
Educating the Blind .....	18		
McIntire Institution for Deaf Mutes .....	2		
Owen Cabinet .....	1		
Public Library .....	4		
<b>Lafayette:</b>			
Pardee University .....	1		
<b>Meran:</b>			
Union Christian College .....	1		
<b>New Albany:</b>			
Society of Natural History .....	3		
Theological Seminary .....	1		
<b>Notre Dame:</b>			
University of Notre Dame .....	1		
<b>Richmond:</b>			
Richmond Scientific Association .....	1		
<b>Saint Mainard:</b>			
St. Mainard College .....	1		
<b>Terre Haute:</b>			
State Normal School .....	1		
<b>INDIAN TERRITORY.</b>			
<b>Armstrong:</b>			
Armstrong Academy .....	3		
<b>IOWA.</b>			
<b>Ames:</b>			
Iowa Agricultural College .....	1		
<b>Burlington:</b>			
Burlington University .....	1		
Iowa Historical and Genealogical Institute .....	9		
<b>Council Bluffs:</b>			
Institution for the Deaf and Dumb .....	2		
<b>Davenport:</b>			
Academy of Natural Sciences .....	242		
Griswold College .....	2		
<b>Decorah:</b>			
Norwegian Lutheran College .....	16		
<b>Des Moines:</b>			
Analyst .....	1		
Department of Public Instruction .....	3		
Geological Survey .....	6		
Governor of Iowa .....	20		
Iowa School Journal .....	1		
State Horticultural Society .....	2		
Library .....	197		
of Iowa .....	16		
<b>Dubuque:</b>			
Iowa Institute of Science and Art .....	9		
<b>Fairfield:</b>			
Jefferson College Library Association .....	1		
<b>Grinnell:</b>			
Grinnell University .....	1		
Iowa College .....	1		
<b>Independence:</b>			
Hospital for the Insane .....	1		
<b>Indianola:</b>			
Simpson Centennial College .....	1		
<b>Iowa City:</b>			
Geological Survey .....	9		
Grand Lodge of Iowa .....	2		
Institution for Deaf and Dumb .....	1		
Iowa Weather Service .....	17		
Laboratory of Physical Sciences .....	2		
State Historical Society .....	2		
of Iowa (see also <i>Des Moines</i> ) .....	9		
University .....	519		
<b>Keokuk:</b>			
Library Association .....	1		
<b>Mount Pleasant:</b>			
Hospital for the Insane .....	2		
Wesleyan University .....	2		
<b>Mount Vernon:</b>			
Cornell College .....	1		
<b>Oscaloesa:</b>			
Oscaloesa College .....	1		
<b>KANSAS.</b>			
<b>Baldwin City:</b>			
Baker University .....	4		
<b>Lawrence:</b>			
Academy of Sciences .....	1		
Kansas Historical Society .....	3		
University of Kansas .....	5		
<b>Leavenworth:</b>			
College of Pharmacy .....	1		
Kansas Academy of Music .....	1		
Mercantile Library Association .....	3		
State Academy of Sciences .....	5		
Young Men's Christian Association .....	1		
<b>Lecompton:</b>			
State Library .....	5		
<b>Olathe:</b>			
Institution for Deaf and Dumb .....	2		
<b>Ossawatimie:</b>			
Hospital for the Insane .....	2		
<b>Topeka:</b>			
Academy of Sciences .....	19		
Kansas Historical Society .....	28		
Natural History Society .....	4		
State Library .....	13		
Washburn College .....	1		
<b>Wyandott:</b>			
Library Association .....	3		
<b>KENTUCKY.</b>			
<b>Ashland:</b>			
Agricultural and Mechanical College .....	1		
<b>Cambridge:</b>			
College .....	1		
<b>Columbia:</b>			
Christian College .....	1		
<b>Danville:</b>			
Center College .....	1		
Institution for the Deaf and Dumb .....	4		
Theological Seminary .....	1		
<b>Farndale:</b>			
Kentucky Military Institute .....	1		
<b>Frankfort:</b>			
Geological Survey of Kentucky .....	126		
Public Library .....	1		
State Library .....	19		

*Distribution of domestic exchanges, &c.—Continued.***Frankfort—Continued.**

Third Kentucky Hospital for the Insane .....	1
<b>Hobbs:</b>	
State Hospital for the Insane ..	1
<b>Hopkinsville:</b>	
Second Kentucky Hospital for the Insane .....	1
Western Lunatic Asylum .....	4
<b>Lebanon:</b>	
St. Mary's College .....	1
<b>Lexington:</b>	
Eastern Lunatic Asylum .....	7
First Kentucky Hospital for the Insane .....	3
Kentucky University .....	5
State Agricultural Society .....	1
Transylvania Medical College ..	1
University .....	3
Young Men's Christian Association .....	1
<b>Louisville:</b>	
College of Pharmacy .....	1
Corporation of the city .....	1
Grand Lodge of Kentucky .....	1
Historical Society of Kentucky ..	8
Louisville and Richmond Medical Journal .....	6
Mayor of the city .....	5
Medical Department, University of Louisville .....	1
Public Library .....	11
University of Louisville .....	15
<b>Russellville:</b>	
Bethel College .....	1
Logan Female College .....	2
<b>Shelbyville:</b>	
Observatory of Shelby College ..	1
Shelby College .....	1

**LOUISIANA.**

<b>Baton Rouge:</b>	
Academy .....	1
Institution for Deaf and Dumb ..	2
State Library .....	21
University .....	9
<b>Clinton:</b>	
Louisiana Insane Asylum .....	2
<b>Grand Coteau:</b>	
St. Charles College .....	1
<b>Jackson:</b>	
Insane Asylum .....	3
<b>New Orleans:</b>	
Athenée Louisianaise .....	4
City Library .....	1
Corporation .....	1
Insane Asylum .....	1
Lyceum of Natural History .....	2
Mayor of the city .....	7
Mechanics' Society Library .....	1
Medical Department, University of Louisiana .....	1
Municipality .....	1
New Orleans Academy of Sciences .....	778
New Orleans Deutsche Zeitung ..	1
State Library .....	49
University of Louisiana .....	10

**MAINE.**

<b>Augusta:</b>	
Board of Agriculture .....	1
Commissioner of Fisheries .....	6
Historical Society of Maine .....	2
Hospital for the Insane .....	4
State Library .....	15
Natural History and Geological Society .....	2
State Lunatic Hospital .....	3
<b>Calais:</b>	
High School and Academy .....	2
<b>Bangor:</b>	
Commissioner of Fisheries .....	2
Mechanics' Association .....	1
<b>Brunswick:</b>	
Bowdoin College .....	78
Historical Society .....	22
<b>Colby:</b>	
Colby University .....	9
College .....	2
<b>Dartmouth:</b>	
Dartmouth College .....	26
<b>Hebron:</b>	
Hebron Academy .....	1
<b>Houlton:</b>	
Forest Club .....	3
<b>Lewiston:</b>	
Androscoggin and Natural History Society .....	1
Manufacturers and Mechanics' Association .....	1
<b>Norway:</b>	
High School and Academy .....	2
<b>Orono:</b>	
Maine State College of Agriculture .....	1
<b>Portland:</b>	
Athenaeum and Public Library ..	1
City Registrar .....	1
Commissioner of Fisheries .....	3
Legislature of Maine .....	1
Maine Agricultural Society .....	1
Historical Society .....	2
Journal of Education .....	1
Mayor of the city .....	3
Portland Society of Natural History .....	248
<b>Saco:</b>	
York Institute .....	2
<b>Waterville:</b>	
Colby University .....	10
Waterville College .....	15

**MARYLAND.**

<b>Annapolis:</b>	
St. John's College .....	3
State Library .....	20
United States Naval Academy ..	23
United States Naval Observatory .....	7
<b>Baltimore:</b>	
Academy of Sciences .....	18
American Journal of Chemistry .....	1
American Journal of Dental Science .....	3



*Distribution of domestic exchanges, &c.—Continued.***Baltimore—Continued.**

American Journal of Mathematics .....	11
Baltimore City College .....	1
Deutsche Zeitung .....	1
College of Pharmacy .....	1
Corporation of the city .....	1
Historical Society of Maryland .....	74
Johns Hopkins University .....	63
Maryland Asylum for the Insane .....	4
Institute .....	4
Mayor of the city .....	6
Mercantile Library .....	3
Loyola College .....	1
Mount Hope Institution .....	2
Municipality .....	2
Newton University .....	1
Odd Fellows' Library .....	1
Paul's Lyceum and Library Association .....	4
Peabody Institute .....	83
St. Mary's College .....	1
State Agricultural Society .....	1
Library .....	12
Normal School .....	1
Superintendent Public Instruction .....	8
University of Maryland .....	2
Young Men's Christian Association .....	1

**Frederick City:**

Institution for the Deaf and Dumb .....	1
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**Hyattsville:**

State Agricultural College .....	1
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**Rockville:**

Rockville Academy .....	1
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**Saint James:**

College of Saint James .....	1
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**Woodstock:**

Woodstock College .....	1
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**MASSACHUSETTS.****Amherst:**

Astronomical Observatory .....	1
Geological Survey of Massachusetts .....	4
Massachusetts Agricultural College .....	17

**Andover:**

Theological Seminary .....	1
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**Boston:**

Agricultural Society .....	1
American Academy of Arts and Sciences .....	3,180
Board for Foreign Missions .....	2
Christian Examiner .....	21
Gynecological Society .....	20
Naturalist .....	5
Social Science Association .....	28
Statistical Association .....	189
Unitarian Association .....	29

**Boston—Continued.**

Appalachian Mountain Club ..	1
Art Museum .....	1
Association for Improving the Condition of the Poor .....	1
Atlantic Monthly .....	1
Board of Education .....	7
Boston Art Club .....	5
Athenaeum .....	29
Journal of Medicine .....	1
Journal of Natural History .....	1
College .....	1
Medical and Surgical Association .....	1
Medical and Surgical Journal .....	70
Observatory .....	1
Scientific Society .....	1
Society of Natural History .....	4,212
University .....	1
Bowditch Library .....	80
Bureau of Statistics and Labor ..	2
City Library .....	3
Commissioners of Insurance .....	1
Commonwealth of Massachusetts ..	6
Corporation of the city .....	1
Christian Register Association ..	23
Day School for Deaf and Dumb ..	1
Department of Public Instruction ..	1
Directors of public institutions ..	1
Geological Survey .....	12
Good Health Journal .....	7
Hospital for the Insane .....	5
House of Correction .....	1
Inspectors of State prisons .....	1
Library of Boston Hospital .....	12
Lyceum of Natural History .....	2
Massachusetts Asylum for the Blind .....	2
Massachusetts College of Pharmacy .....	1
Massachusetts Historical Society ..	109
Massachusetts Horticultural Society ..	1
Massachusetts Institute of Technology .....	17
Massachusetts Society for Prevention of Cruelty to Animals .....	2
Massachusetts State Board of Agriculture .....	47
Massachusetts State Board of Charities .....	28
Massachusetts State Board of Health .....	41
Massachusetts State Library .....	197
Massachusetts Teacher .....	1
Mayor of the city .....	8
McLean Hospital for the Insane .....	1
Medical Gazette .....	3
Society .....	1
Mercantile Library .....	5

*Distribution of domestic exchanges, &c.—Continued.***Boston—Continued.**

Microscopical Society .....	1
Municipality .....	1
New England Historical and Genealogical Society .....	58
North American Review .....	39
Ornithological Club .....	1
Perkins' Institute for the Blind ..	18
Philosophical Society .....	1
Prison Discipline Association ..	19
Public Library .....	433
Sanitary Commission .....	2
Institute .....	1
Science Observer .....	1
Society for the Development of Mineral Resources .....	1
Worcester County Horticultu- ral Society .....	1
Young Men's Christian Associa- tion .....	1

**Brookline:**

Public Library .....	1
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**Cambridge:**

American Association for the Advancement of Science ....	391
Astronomical Journal .....	143
Athenum .....	1
Botanical Garden .....	8
Museum .....	1
Cloverdon Observatory .....	1
Dane Library .....	3
Entomological Club "Psyche" ..	24
Harvard College .....	889
Observatory .....	736
Natural History So- ciety .....	1
Herbarium of Harvard College ..	12
Institution for the Blind .....	2
Law School Library .....	1
Lawrence Scientific School .....	2
Museum of Comparative Zo- ology .....	1,024
National Academy of Sciences ..	32
Nautical Almanac .....	3
Nuttall Ornithological Club ...	2
Peabody Museum .....	42
Philosophical Society .....	2
Theological School Library .....	1

**College Hill:**

Tuft's College .....	1
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**Concord:**

Public Library .....	1
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**Dorchester:**

State Board of Health .....	4
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**Haverhill:**

Public Library .....	1
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**Gloucester:**

Sawyer Free Library .....	2
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**Hingham:**

Public Library .....	1
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**Jamaica Plain:**

Bussey Institution .....	117
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**Lancaster:**

Town Library .....	1
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**Lawrence:**

Public Library .....	1
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**Leicester:**

Public Free Library .....	4
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**Lowell:**

Mechanics' Association .....	1
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**Lynn:**

Public Library .....	1
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Society of Natural History ....	2
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**Manchester:**

Literary and Philosophical So- ciety .....	1
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**Nantucket:**

Athenum .....	1
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**Newburyport:**

Public Library .....	1
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**Newton Center:**

Theological Institution .....	7
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**Northampton:**

Clarke Institution for Deaf Mutes .....	7
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Public Library .....	1
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State Lunatic Asylum .....	7
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**Pittsfield:**

Library Association .....	1
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**Quincy:**

Public Library .....	1
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**Salem:**

American Association for the Advancement of Science .....	459
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Naturalist .....	51
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Oriental Society .....	7
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Athenum .....	1
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Essex Institute .....	1,135
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North Church and Society .....	2
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Peabody Academy .....	942
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**Penekese Island:**

Anderson School .....	7
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**Somerville:**

McLean Asylum for the Insane ..	3
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**South Hadley:**

Mount Holyoke Female Semi- nary .....	1
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**Springfield:**

City Library Association .....	1
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**Taunton:**

Public Library .....	1
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State Lunatic Hospital .....	8
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**Watertown:**

Free Public Library .....	1
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**Wellesley:**

Wellesley College .....	9
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**Williamstown:**

Astronomical Observatory .....	1
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Williams College .....	1
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**Woburn:**

Public Library .....	1
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**Worcester:**

American Antiquarian Society ..	258
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Catholic College .....	1
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Free Institute of Industry .....	1
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Public Library .....	4
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Society of Natural History .....	1
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State Hospital for the Insane ..	7
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Technological Institution .....	6
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Worcester Academy .....	1
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**MICHIGAN.****Adrian:**

Adrian College .....	1
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*Distribution of domestic exchanges, &c.—Continued.*

<i>Ann Arbor:</i>		<i>Saint Peter:</i>	
Detroit Observatory .....	4	Institution for the Insane .....	4
Geological Survey of Michigan .....	13		
Herbarium of the University .....	1		
Observatory .....	193	MISSISSIPPI.	
Society of Agriculture .....	1	<i>Clinton:</i>	
University of Michigan .....	45	Mississippi College .....	1
<i>Coldwater:</i>		<i>Daleville:</i>	
Michigan Library Association .....	26	Cooper Institute .....	1
<i>Detroit:</i>		<i>Jackson:</i>	
Geological Survey of Michigan .....	2	Hospital for the Insane .....	3
Historical Society of Michigan .....	4	Institution for the Deaf and	
House of Correction .....	1	Dumb .....	1
Museum .....	1	State Historical Society .....	3
Peninsula and Independent		Library .....	21
Medical Journal .....	4	Lunatic Asylum .....	2
Public Library .....	4		
St. Philipp's College .....	1	<i>Natches:</i>	
State Agricultural Society .....	250	Public Library .....	2
Survey of the North American		<i>Oxford:</i>	
Lakes .....	1	University of Mississippi .....	11
<i>Flint:</i>			
Institution for the Deaf and		MISSOURI.	
Dumb .....	3	<i>Columbia:</i>	
<i>Hillsdale:</i>		Agricultural College .....	1
Hillsdale College .....	1	Geological Survey of Missouri .....	81
<i>Kalamazoo:</i>		State Library .....	1
Asylum for the Insane .....	4	University of Missouri .....	23
College .....	1	<i>Fulton:</i>	
Geological Survey .....	3	Institution for the Deaf and	
<i>Lansing:</i>		Dumb .....	3
Agricultural College .....	3	State Lunatic Asylum .....	7
Geological Survey .....	16	<i>Glasgow:</i>	
State Agricultural Society .....	71	Morrison Observatory .....	4
Board of Health .....	68	<i>Jefferson:</i>	
Library .....	17	Governor of Missouri .....	4
<i>Marquette:</i>		Historical Society .....	14
Geological Survey .....	1	State Board of Agriculture .....	20
<i>Olivet:</i>		Library .....	14
Olivet College .....	1	<i>Kansas City:</i>	
<i>Port Huron:</i>		Kansas Review .....	1
Ladies' Library Association ...	1	Western Review .....	1
		Young Men's Christian Asso-	
MINNESOTA.		ciation .....	3
<i>Duluth:</i>		<i>Liberty:</i>	
Free Public Library .....	1	William Jewell College Library	4
Scandinavian Library .....	1	<i>Rolla:</i>	
<i>Faribault:</i>		Geological Survey of Missouri .....	15
Institution for the Deaf and		School of Mines .....	2
Dumb .....	2	<i>Saint Louis:</i>	
<i>Minneapolis:</i>		Academy of Sciences .....	2,487
Geological Survey .....	3	Botanical Garden .....	1
Minnesota Academy of Sciences	65	Catholic Institute for Deaf and	
University of Minnesota .....	4	Dumb .....	1
<i>Red Wing:</i>		College of Pharmacy .....	1
Hamlin University .....	1	County Hospital for the Insane .....	1
<i>San Anthony:</i>		Corporation .....	1
University of Minnesota .....	5	Deutsches Institut zur Beför-	
<i>Saint Paul:</i>		derung der Wissenschaften,	
Academy of Natural Sciences ..	6	Kunst und Gewerbe .....	20
Chamber of Commerce .....	7	Geological Survey of Missouri .....	62
Institution for the Deaf and		Governor of the State .....	3
Dumb .....	1	Humboldt Medical College .....	1
Minnesota Historical Society ..	109	Institution for the Deaf and	
Library Association .....	1	Dumb .....	4
Northwestern Medical and Sur-		Law Library .....	1
gical Journal .....	1	Mayor of the City .....	9
State Library .....	4	Medical Archives of St. Louis ..	1
		Mercantile Library .....	15

*Distribution of domestic exchanges, &c.—Continued.*

<i>Saint Louis</i> : Continued.		<i>Mount Holly</i> :	
Missouri Dental Journal .....	7	Lyceum of History and Natural Sciences .....	1
Historical Society .....	3	<i>Newark</i> :	
Peabody Academy .....	3	Historical Society of New Jersey .....	16
Polytechnic Department of the University .....	1	<i>New Brunswick</i> :	
Public Library .....	3	Geological Survey of New Jersey .....	88
School Library .....	20	Natural History Society .....	1
St. Louis Medical and Surgical Journal .....	11	Rutgers Scientific School .....	8
St. Vincent Hospital for the Insane .....	1	<i>Newton</i> :	
State Bureau of Geology and Mines .....	1	Newton Library Association .....	1
Washington University .....	53	<i>Princeton</i> :	
Westliche Post .....	1	Agricultural Society .....	1
<i>Warrensburg</i> :		College of New Jersey .....	174
State Normal School .....	1	Green School of Science .....	3
		Halstead Observatory .....	2
		Horticultural Society .....	1
		Observatory .....	10
		Pharmaceutical Society .....	1
		Theological Seminary .....	1
		<i>Rahway</i> :	
		Library Association .....	1
		<i>Salem</i> :	
		Salem Academy .....	1
		<i>Trenton</i> :	
		Geological Survey .....	6
		State Library .....	19
		Lunatic Asylum .....	8
		NEW MEXICO.	
		<i>Santa Fé</i> :	
		Historical Society of New Mexico .....	3
		Territorial Library .....	3
		NEW YORK.	
		<i>Albany</i> :	
		Adirondack Survey Office .....	18
		Albany Library .....	1
		Institute .....	229
		Bureau of Military Statistics .....	9
		Commissioners State Park .....	2
		Dudley Observatory .....	450
		Governor of the State .....	2
		Homoeopathic Society .....	2
		Inspector of Penitentiaries .....	1
		State Prisons .....	1
		New York State Agricultural Society .....	529
		Cabinet of Natural History .....	102
		Literary Society .....	1
		Medical Society .....	35
		Museum of Natural History .....	22
		Regents of N. Y. University .....	110
		Secretary of State .....	4
		State Board of Charities .....	1
		Library .....	888
		Normal School .....	1
		Superintendent of Insurance .....	3
		Young Men's Christian Association .....	1
		<i>Alfred Centre</i> :	
		Observatory .....	3

*Distribution of domestic exchanges, &c.—Continued.*

<i>Annandale:</i>		<i>Governor's Island:</i>	
St. Stephen's College.....	1	Military Service Institution...	1
<i>Auburn:</i>		<i>Hamilton:</i>	
Agricultural and Mechanical College.....	1	Madison University.....	10
Hospital for the Criminal Insane.....	3	<i>Hornellsville:</i>	
Theological Seminary.....	1	Library Association.....	1
<i>Bath:</i>		<i>Hudson:</i>	
Library Association.....	1	Observatory.....	1
<i>Blackwell's Island:</i>		<i>Ithaca:</i>	
New York Lunatic Asylum....	12	Cornell University.....	59
<i>Binghamton:</i>		<i>Jamestown:</i>	
Institution for the Blind.....	1	Microscopical Society.....	4
<i>Brooklyn:</i>		<i>Le Roy:</i>	
Baker Collegiate Institute.....	1	Ingham University.....	1
Brooklyn Library.....	5	<i>Lima:</i>	
Collegiate and Polytechnic Institute.....	1	Genesee College.....	1
Entomological Society.....	4	Wesleyan Seminary.....	1
King's County Medical Society.....	2	<i>Newburgh:</i>	
Long Island Historical Society.....	21	Theological Seminary Association, Reform Church.....	1
Mayor of the city.....	3	<i>New York:</i>	
Mercantile Library Association.....	5	Agricultural Intelligencer.....	1
Statistical Society of Brooklyn.....	2	American Agriculturist.....	6
Young Men's Christian Association.....	1	Bible Society.....	5
<i>Buffalo:</i>		Bureau of Mines.....	4
Buffalo Historical Society.....	17	Chemical Society.....	30
Medical Association.....	1	Chemist.....	33
Practical School.....	4	Christian Commission.....	100
Society of Natural Sciences.....	463	Druggists' Circular.....	3
Grosvenor Library.....	9	Episcopal Theological Seminary.....	1
Institution for the Deaf and Dumb.....	1	Ethnological Society.....	110
Medical and Surgical Journal.....	7	Geographical Society.....	1,238
North American Entomologist.....	1	Institute.....	354
Observatory.....	2	of Architects.....	55
Society of Natural History.....	2	Journal of Chemistry.....	2
Young Men's Christian Association.....	2	Microscopy.....	4
Young Men's Library.....	1	Mining.....	19
<i>Canandaigua:</i>		Obstetrics.....	1
Brigham Hall's Hospital.....	2	Medical Eclectic Review.....	2
<i>Canton:</i>		Medical Journal.....	24
St. Lawrence University.....	3	Microscopical Society.....	13
<i>Clinton:</i>		Museum of Natural History.....	166
Hamilton College.....	1	Missionary Society.....	12
Litchfield Observatory of Hamilton College.....	24	Naturalist.....	1
<i>Corning:</i>		Public Health Association.....	7
Corning Library.....	1	Society of Civil Engineers.....	64
<i>Cornwall:</i>		Anthropological Institute of New York.....	115
Cornwall Library.....	1	Apprentices' Library.....	3
<i>Elmira:</i>		Astor Library.....	293
Elmira Academy of Sciences.....	4	Austrian Consul.....	1
Young Men's Christian Association.....	1	Bavarian Consul.....	1
<i>Flatbush:</i>		Board of Education.....	1
King's County Hospital for the Insane.....	4	Bloomingtondale Asylum for the Insane.....	5
<i>Flushing:</i>		Chamber of Commerce.....	4
Sanford Hall Asylum.....	1	Christian Inquirer office.....	14
<i>Fordham:</i>		College of Pharmacy.....	2
St. John's College.....	1	Physicians and Surgeons.....	1
<i>Geneva:</i>		the City of New York.....	1
Hobart College.....	1		

*Distribution of domestic exchanges, &c.—Continued.**New York—Continued.*

Columbia College.....	42
Commissioners, Central Park..	2
Cooper Union.....	9
Courrier des États-Unis.....	1
Dermatological Society.....	1
Eclectic Medical College.....	1
Engineering and Mining Journal.....	100
Farmer and Mechanic.....	4
Farmers' and Mechanics' Intelligenceer.....	1
General Society of Mechanics and Tradesmen.....	1
Gynecological Society.....	2
Herbarium of Columbia College.....	4
Historical Society.....	67
Homeopathic Sun.....	1
Institution for the Blind.....	4
Deaf and Dumb.....	3
Instruction of Deaf and Dumb.....	3
Insurance Department.....	7
International Review.....	2
Lenox Library.....	10
Journal of Psychological Medicine.....	7
Liberal Christian Library Journal.....	8
Manufacturer and Builder.....	65
Mayor of the city.....	9
Mechanics' Institute.....	1
Medical College.....	1
Gazette.....	4
Library and Journal Association.....	1
Record.....	2
Recorder.....	2
Society.....	1
Mercantile Library Association.....	65
Merchants and Clerks' Library Association.....	1
Meteorological Observatory.....	51
Metropolitan Board of Health.....	16
Museum of Art.....	34
Mexican Consul.....	1
Municipality.....	1
National Board of Underwriters.....	1
Natural History Society.....	1
New York Academy of Sciences.....	1041
Medicine.....	56
Belletristisches Journal.....	1
City Lunatic Asylum.....	3
Dental Journal.....	5
Handels Zeitung.....	2
Herald.....	1
Hungarian Society.....	2
Journal of Pharmacy.....	4
Lycœum of Natural History.....	950
Medical Journal.....	4
Medico-Historical Society.....	3
Society Library.....	5
of Libraries.....	1
Staats Zeitung.....	1

*New York—Continued.*

New York Statistical Society....	1
Times.....	12
Tribune.....	3
Norton's Library Gazette.....	4
Numismatic and Archæological Society.....	13
Philosophical Society.....	1
Prison Association.....	6
Public Health Association.....	1
School Society.....	1
Sanitarian.....	79
School of Mines.....	128
Scientific American.....	7
Scottish American Journal.....	3
Society for the Protection of Animals.....	1
State Commissioners of Public Charities.....	2
Swedenborg Society.....	1
Swedish-Norwegian Consulate.....	4
The Nation.....	1
Torrey Botanical Club.....	1
União Científico Brasileiro....	1
Union Theological Seminary....	3
University of New York.....	75
United States Sanitary Commission.....	128
Van Nostrand's Magazine.....	4
Young Men's Christian Association.....	1
Young Men's Christian Association, German.....	1
Poughkeepsie:	
Public Library.....	5
Hudson River Insane Asylum..	1
Society of Natural Sciences.....	12
Vassar Female College.....	24
Rochester:	
Theological Seminary.....	2
University.....	9
Randall's Island:	
House of Refuge.....	1
Schenectady:	
Union College.....	15
Sing Sing:	
State Lunatic Asylum.....	1
Prison.....	1
Syracuse:	
Public Library.....	2
University.....	4
Troy:	
Female Seminary.....	1
Marshall Infirmary.....	1
Rensselaer Polytechnic Institute.....	4
Young Men's Christian Association.....	1
Utica:	
American Journal of Insanity..	35
State Lunatic Asylum.....	15
Ward's Island:	
Emigrant's Refuge and Hospital.....	2
West Point:	
Observatory.....	1
President, Committee of Engineers.....	1

*Distribution of domestic exchanges, &c.—Continued.*

<i>West Point—Continued.</i>		<i>Columbus:</i>	
United States Military Academy	29	Bureau of Statistics	4
<i>Willard:</i>		Central Lunatic Asylum	1
Willard Asylum for the Insane.	2	Geological Survey of Ohio	45
NORTH CAROLINA.		Horticultural Society	15
<i>Chapel Hill:</i>		Hospital for the Insane	4
University of North Carolina	7	Institution for Deaf and Dumb	3
<i>Davidson College:</i>		Ohio Lunatic Asylum	1
Library	1	State Agricultural Society	92
<i>Lenoir:</i>		Board of Agriculture	1,207
Davenport Female College	1	Library	96
<i>Raleigh:</i>		University	1
Hospital for the Insane	5	<i>Dayton:</i>	
Institution for the Deaf and Dumb	3	Hospital for the Insane	4
State Library	23	Public Library	1
<i>Trinity College:</i>		<i>Delaware:</i>	
Geological School	1	Ohio Wesleyan University	12
Trinity College	1	<i>Fremont:</i>	
<i>Warrenton:</i>		Burchard Library	1
Female College	1	<i>Gambier:</i>	
OHIO.		Kenyon College	56
<i>Ashtabula:</i>		<i>Granville:</i>	
Anthropological Society	6	Dennison University	2
<i>Athens:</i>		<i>Hiram:</i>	
University	9	Hiram College	1
<i>Cincinnati:</i>		<i>Hudson:</i>	
Academy of Medicine	1	Western Reserve College	19
American Freemason	1	Observatory	1
Medical College	9	<i>Lebanon:</i>	
Journal	2	Mechanics' Institute	1
Astronomical Society	5	<i>Marietta:</i>	
Cincinnati Lancet	1	Marietta College	1
Quarterly Journal of Science	6	<i>New Athens:</i>	
College of Pharmacy	1	Franklin College	1
Dental Register	18	<i>Newburg:</i>	
Geological Society	1	Northern Ohio Lunatic Asylum	5
Historical and Philosophical Society	21	<i>North Bend:</i>	
Mayor of the city	6	Horticultural Society of Ohio	14
Mechanics' Institute	7	<i>Oberlin:</i>	
Medical College of Ohio	3	Oberlin College	4
Mercantile Library	42	<i>Oxford:</i>	
Municipality	1	Miami University	5
Mussey Medical Library	1	<i>Painesville:</i>	
National Normal	1	Lake Erie Female Seminary	1
Observatory	404	<i>Mill Creek:</i>	
Public Library	34	Lunatic Asylum	3
Society of Natural History	43	<i>Springfield:</i>	
University of Cincinnati	10	Public Library	1
Volkblatt	1	<i>Tiffin:</i>	
Volkzeitung	1	Heidelberg College	2
Western Academy of Sciences	2	Theological College of the German Reform Church	1
Young Men's Mercantile Library	3	<i>Urbana:</i>	
Zoological Society	1	Central Ohio Scientific Association	7
<i>Cleveland:</i>		Urbana University	5
Academy of Natural Sciences	10	<i>Westerville:</i>	
Case Library	1	Otterbein University	3
Kirtland Society	7	<i>Wooster:</i>	
Observatory	2	Wooster University	1
Public School Library	1	<i>Yellow Springs:</i>	
University	1	Antioch College	5
<i>Carthage:</i>		OREGON.	
Longview Hospital for the Insane	5	<i>Forestville:</i>	
		Pacific University	1
		<i>Oregon City:</i>	
		University of Oregon	1

*Distribution of domestic exchanges, &c.—Continued.*

<b>Portland:</b>		<b>Philadelphia:</b>	
Library Association .....	1	Academy of Fine Arts .....	1
Hospital for the Insane .....	1	Natural Sciences .....	4,576
<b>Salem:</b>		Agricultural Society of Penn-	
Institution for the Deaf and		sylvania .....	1
Dumb .....	1	American Entomological Soci-	
State Library .....	4	ety .....	296
Willamette Observatory .....	1	Institute of Archi-	
University .....	1	tects .....	3
<b>PENNSYLVANIA.</b>		Journal of Conchology .....	49
<b>Allegheny:</b>		Journal of Dental	
Allegheny Observatory .....	61	Sciences .....	1
Society of Natural Sciences .....	2	Journal of Medical	
Western State Penitentiary .....	1	Sciences .....	7
Theological Seminary .....	1	Naturalist .....	25
<b>Bethlehem:</b>		Pharmaceutical Soci-	
Lehigh University .....	3	ety .....	423
Packer University .....	6	Philosophical Society .....	2,753
<b>Carlisle:</b>		Apprentices' Library .....	1
Carlisle Society of Literature .....	6	Asylum for the Insane .....	2
Dickinson College .....	12	Atheneum .....	2
<b>Chester:</b>		Board of Health .....	4
Crozer Theological Seminary .....	1	Inspectors of County	
<b>Dizmont:</b>		Prisons .....	1
Western Hospital for the In-		Public Charities .....	2
sane .....	1	Education .....	22
<b>Danville:</b>		Publications .....	1
Northern Hospital for the In-		Trade .....	8
sane .....	4	Central High School .....	260
<b>Easton:</b>		School Observa-	
American Institute of Mining		tory .....	8
Engineers .....	52	College of Pharmacy .....	3
Lafayette College .....	14	Physicians .....	3
Northwestern University .....	1	Commissioners Fairmount Park	
Pardee Science School .....	1	Corporation of the city .....	1
<b>Frankford:</b>		Curator of Birds, Philadelphia	
Friends' Asylum for the Insane .....	3	Museum .....	1
<b>Germantown:</b>		Dental Cosmos .....	11
Germantown Literary Associa-		Enquirer .....	1
tion .....	4	Laboratory .....	3
<b>Gettysburg:</b>		Times .....	6
Pennsylvania College .....	1	Eastern State Penitentiary .....	2
Theological Seminary .....	2	Entomological Society of Phila-	
<b>Harrisburg:</b>		delphia .....	10
Adjutant-General .....	1	Evening Bulletin .....	1
Harrisburg Academy .....	1	Franklin Institute .....	559
Medical Society of the State .....	10	Journal .....	9
Second Geological Survey of		Friends' Bookstore .....	1
Pennsylvania .....	16	Insane Asylum .....	1
State Agricultural Society .....	3	Geological Society .....	3
Library .....	59	Survey of Pennsyl-	
Lunatic Hospital .....	13	vania .....	24
<b>Haverford:</b>		German Society .....	1
Haverford College .....	2	Girard College .....	11
<b>Kellyville:</b>		Historical Society of Pennsyl-	
Woodbury Retreat .....	1	vania .....	154
<b>Lewisburg:</b>		House of Refuge .....	5
University .....	9	Jefferson Medical College .....	5
<b>Mansfield:</b>		Library Association of Friends .....	2
State Normal School .....	1	Library Company .....	102
<b>Meadville:</b>		of Pennsylvania Hos-	
Theological Seminary .....	1	pital .....	112
<b>Media:</b>		Magnetic and Meteorological	
Delaware County Institute of		Observatory .....	2
Science .....	15	Mayor of the city .....	7
<b>New Wilmington:</b>		Medical and Chirurgurgical Jour-	
Westminster College .....	1	nal .....	13



*Distribution of domestic exchanges, &c.—Continued.**Philadelphia—Continued.*

Medical and Surgical Reporter	4
Review	5
Society of Pennsylvania	4
Times	116
Mercantile Library	8
Mexican Commission	2
Municipality	2
Naturalists' Leisure Hour	1
Naval Review	1
North American Medico-Chirurgical Review	17
Numismatic and Antiquarian Society	6
and Archaeological Society	8
Observatory	8
of Girard College	27
Office of Gray's Atlas	1
Penn Monthly	1
Penn's Hospital	1
Pennsylvania Horticultural Society	23
Hospital for the Insane	7
Institute for the Blind	126
Institute for the Deaf and Dumb	13
Pennsylvania Society for Prevention of Cruelty to Animals	2
Philadelphia Hospital	1
Journal of Medicine	1
Philadelphia Society for Promoting Agriculture	2
Polytechnic Bulletin	1
College	2
Review	1
Public Schools	6
Royal Bavarian Consulate	1
Social Science Association	2
Society for Alleviating the Miseries of Public Prisons	6
Society for the Protection of Animals	69
Stacey Stone-Dressing Machine Company	1
State Lunatic Asylum	1
University of Pennsylvania	23
United States Mint	2
Wagner Free Institute	208
Zoological Garden	2
Society	89

*Pittsburgh:*

Day School for Deaf and Dumb	1
German Library	1
Mercantile Library	2
National Iron and Steel Publishing Company	3
Western Pennsylvania Hospital for the Insane	3
Penitentiary	1

*Sharon:*

Observatory	1
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*South Bethlehem:*

Lehigh University	8
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*Strathmore:*

Strathmore College	1
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*Washington:*

Western College	1
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*West Grove:*

East Pennsylvania Experimental Farm	1
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## RHODE ISLAND.

*Newport:*

Mechanics' Library	1
Redwood Library	3
Society of Science	1

*Providence:*

American Naturalist	15
Atheneum	4
Brown University	99
Butler Hospital for the Insane	4
City Registrar's Office	4
Normal School	1
Public Library	1
Registrar-General for Rhode Island	1
Rhode Island Historical Society	53
Secretary of State	2
Society for the Encouragement of Domestic Industries	1
State Library	17

*Woonsocket:*

Harris Institute Library	1
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## SOUTH CAROLINA.

*Cedar Springs:*

Institute for the Deaf and Dumb	1
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*Charleston:*

Charleston Journal of Medicine	1
Medical Journal and Review	2
Museum of Natural History	2
Observatory	5
College of Charleston	3
Elliott Society of Natural History	376
Library Society	28
Literary and Philosophical Society	2
Medical School of South Carolina	1
Public Library	2
South Carolina College Library	1
Historical Society	22
Medical Association	6
Society Library	22
State Medical College	2
University of Charleston	1
Columbia:	
South Carolina College	29
State Library	19
Lunatic Asylum	1
University — Geological Rooms	2
Theological Seminary	1
University of South Carolina	16
Due West:	
Erskine College	1

*Distribution of domestic exchanges, &c.—Continued.*

<b>Greenville:</b>		<b>Derby:</b>	
Furman University .....	1	Society of Natural Sciences....	1
<b>Lexington:</b>		<b>Montpelier:</b>	
Theological Seminary .....	1	Historical and Antiquarian So-	
		ciety .....	7
		Society .....	9
		State Cabinet of Natural His-	
		tory .....	1
		Library .....	89
		<b>Rutland:</b>	
		Pharmaceutical Association ...	1
		<b>St. Johnsbury:</b>	
		Athenum .....	1
		VIRGINIA.	
		<b>Blacksburg:</b>	
		Agricultural and Mechanical	
		College .....	1
		<b>Charlottesville:</b>	
		University of Virginia .....	105
		<b>Emory:</b>	
		Emory and Henry College ....	1
		<b>Hampden-Sydney:</b>	
		Hampden-Sydney College .....	6
		<b>Hampton:</b>	
		Hampton College .....	1
		Normal Institute ....	3
		Union Theological Seminary...	3
		<b>Lexington:</b>	
		School of Civil Engineers ....	2
		Virginia Military Institute ....	3
		Washington and Lee Univer-	
		sity .....	3
		<b>Lynchburg:</b>	
		Medical Society of Virginia ...	1
		Young Men's Christian Associa-	
		tion .....	1
		<b>New Market:</b>	
		Polytechnic Institute .....	4
		<b>Richmond:</b>	
		Medical Society .....	10
		Richmond College .....	2
		Medical College ....	1
		Southern Fertilizing Company.	1
		State Library .....	43
		University .....	1
		Virginia Historical Society....	20
		Young Men's Christian Associa-	
		tion .....	1
		<b>Salem:</b>	
		Roanoke College .....	1
		<b>Staunton:</b>	
		Institution for the Deaf and	
		Dumb .....	3
		Western Insane Hospital .....	7
		<b>Williamsburg:</b>	
		Eastern Lunatic Asylum .....	19
		WASHINGTON TERRITORY.	
		<b>Olympia:</b>	
		Territorial Library .....	16
		<b>Seattle:</b>	
		Territorial Library .....	1
		<b>Stellacoom:</b>	
		Insane Asylum .....	1
		WEST VIRGINIA.	
		<b>Charleston:</b>	
		State Library .....	3

**Greenville:**

Furman University .....

**Lexington:**

Theological Seminary .....

## TENNESSEE.

**Columbia:**

Athenum .....

Jackson College .....

**Hiwassee:**

Hiwassee College .....

**Jackson:**

Southern Baptist University...

**Knoxville:**

Cumberland University .....

East Tennessee University ....

Institution for Deaf and Dumb.

Tennessee Philomathesian So-

ciety .....

**Lebanon:**

Cumberland University .....

**Marysville:**

Marysville College .....

South West Theological Sem-

inary .....

**Memphis:**

Christian Brothers College ....

**Nashville:**

Geological Survey .....

Historical Society of Tennessee.

Hospital for the Insane .....

Institution for the Blind .....

State Library .....

University .....

Vanderbilt University .....

## TEXAS.

**Austin:**

Institution for the Deaf and

Dumb .....

Public Library .....

State Library .....

Lunatic Asylum .....

University of Texas .....

**Bonham:**

Geological Survey .....

**Chapel Hill:**

Soulé University .....

**Independence:**

Ballor University .....

## UTAH.

**Salt Lake City:**

Territorial Library .....

University of the Desert .....

## VERMONT.

**Barnet:**

Historical and Antiquarian So-

ciety .....

**Brattleboro:**

State Lunatic Asylum .....

**Burlington:**

City clerk .....

Fletcher Free Public Library..

University of Vermont .....

**Castleton:**

Orleans County Society of Nat-

ural Sciences .....

*Distribution of domestic exchanges, &c.—Continued.*

<i>Flemington:</i>		<i>Madison—Continued.</i>	
West Virginia College .....	1	Natural History Society.....	4
<i>Romney:</i>		Observatory .....	1
Institution for the Deaf and		Skandinaviske Presse Forening	6
Dumb .....	1	Society for Educating the Blind	2
West Virginia Hospital for the		State Agricultural Society.....	615
Insane.....	1	Historical Society.....	146
<i>Shepherdstown:</i>		Library .....	60
Shepherd's College.....	1	Superintendent of Public In-	
<i>Wheeling:</i>		struction .....	1
Natural History Society.....	1	University of Wisconsin .....	17
WISCONSIN.		Washburn Observatory .....	12
<i>Appleton:</i>		Young Men's Christian Associa-	
Lawrence University .....	6	tion .....	1
<i>Beloit:</i>		<i>Milwaukee:</i>	
Beloit College .....	1	Catholic Seminary .....	1
Geological Survey of Wisconsin	8	German Natural History Society	2
<i>Delavan:</i>		Milwaukee Seebote .....	1
Institution for Deaf and Dumb.	3	Milwaukee University .....	3
<i>Duluth:</i>		Naturhistorischer Verein .....	95
Scandinavian Library.....	3	Public Library .....	1
<i>Galesville:</i>		Skandinaviske Presse Forening	2
Galesville University .....	5	Young Men's Christian Associa-	
<i>Inmanville:</i>		tion .....	1
Scandinavian Society .....	11	<i>Neeah:</i>	
<i>Janesville:</i>		Scandinavian Literary Associa-	
Institution for Educating the		tion .....	1
Blind .....	47	Wisconsin Scandinavian Libra-	
University .....	2	ry .....	19
<i>Madison:</i>		<i>Pine Lake:</i>	
Academy of Sciences.....	304	Wisconsin Scandinavian Socie-	
Agriculture Department.....	2	ty.....	3
College of Arts .....	2	<i>Racine:</i>	
Educational Society.....	1	College Library.....	2
Office of Emigration .....	4	WYOMING.	
Geological Survey .....	2	<i>Cheyenne:</i>	
Hospital for the Insane .....	1	Territorial Library .....	3

## RECAPITULATION.

Alabama .....	44	Nebraska .....	26
Arizona .....	6	Nevada .....	3
Arkansas .....	416	New Hampshire .....	237
California .....	1,487	New Jersey .....	401
Colorado .....	15	New Mexico .....	6
Connecticut .....	3,461	New York .....	9,070
Delaware .....	9	North Carolina .....	43
District of Columbia .....	15,518	Ohio .....	2,296
Florida .....	10	Oregon .....	11
Georgia .....	116	Pennsylvania.....	10,634
Idaho .....	3	Rhode Island .....	208
Illinois .....	1,634	South Carolina .....	548
Indiana .....	182	Tennessee .....	105
Indian Territory .....	3	Texas .....	104
Iowa .....	1,101	Utah .....	6
Kansas .....	101	Vermont .....	473
Kentucky .....	239	Virginia .....	243
Louisiana .....	896	Washington .....	18
Maine .....	473	West Virginia .....	8
Maryland .....	369	Wisconsin .....	1,398
Massachusetts .....	15,423	Wyoming .....	3
Michigan .....	742	Individuals, United States .....	} 23,505
Minnesota .....	215	Societies .....	
Mississippi .....	45	Individuals..	
Missouri .....	2,908		
Montana .....	3	Total .....	94,765

### III.—GOVERNMENT EXCHANGES.

Although Congress, by act July 20, 1840, authorized the printing and binding of fifty copies of all volumes published by the two Houses, which volumes were to be reserved for the purpose of exchange with foreign powers, yet from the omission to provide for the extra printing, or from other cause, this liberal arrangement failed to go into operation.

An act of March 4, 1846, directed the Librarian of Congress to procure a complete series of reports of the United States courts and of the laws of the United States, and transmit them to the minister of justice of France, in exchange for works of French law presented to the United States Supreme Court.

By act of June 26, 1848, the Joint Committee on the Library was authorized to appoint agents for exchange of books and public documents. All books transmitted through these agents of exchange, for use of the United States, for any single State, or for the Academy at West Point, or the National Institute, to be admitted free.

A resolution of June 30, 1848, ordered that the Joint Committee on the Library be furnished with twenty-five copies of the Revolutionary Archives, twenty-five copies of Little & Brown's edition of the Laws of the United States, seven copies of the Exploring Expedition then published, and an equal number of subsequent publications on the same subject, for the purpose of international exchange.

A joint resolution of March 2, 1849, directed that two copies of certain volumes of the Exploring Expedition be sent to the Government of Russia, in lieu of those which were lost at sea on their passage to that country. The Secretary of State was also directed to present a copy of the Exploring Expedition, as soon as completed, to the Government of Ecuador.

By the act of August 31, 1852, the act of 1848 regulating exchanges was repealed.

In 1852 the Smithsonian Institution urged that Congress should make some systematic and permanent arrangement for distributing complete series of its works to European libraries, to at least thirty of which they might be judiciously supplied. It was also suggested that particular works of scientific interest, as reports of patents, coast-survey operations, government explorations in geography and geology, and others of a similar character, might be assigned in larger numbers of from one hundred to three hundred, as had already been done in some instances by the Senate. These might be distributed by the Smithsonian Institution at moderate cost to the government, and direct returns or exchanges obtained for the Library of Congress, if desired. The distribution of Congressional documents in the United States could also be advantageously modified. The copies given to the State Department for domestic distribution were sent only to colleges or lyceums, not to regular public libraries, even of the largest class. The rule in force with the

Smithsonian Institution might well be applied in this case, of making as equable a distribution as possible throughout the country, supplying all larger public libraries, and giving to smaller ones only where a large district would otherwise be destitute. It had always been matter of complaint with men pursuing special objects of research that public documents relating to their investigations were frequently inaccessible. In order to remedy this, some department could be directed to keep full lists of all persons prominently engaged in the various branches of science, and to supply the names on such list regularly with extra copies of documents to be furnished by Congress.

By act of August 18, 1856, the Secretary of State was authorized to purchase one hundred copies each of Audubon's Birds of America and Quadrupeds of North America, for exchange with foreign governments for valuable works.

The matter of government exchanges received, however, no further definite action until 1867, when the following act was passed:

A RESOLUTION to provide for the exchange of certain public documents.

*Resolved by the Senate and House of Representatives of the United States in Congress assembled,* That fifty copies of all documents hereafter printed by order of either House of Congress, and fifty copies additional of all documents printed in excess of the usual number, together with fifty copies of each publication issued by any department or bureau of the government, be placed at the disposal of the Joint Committee on the Library, who shall exchange the same, through the agency of the Smithsonian Institution, for such works published in foreign countries, and especially by foreign governments, as may be deemed by said committee an equivalent; said works to be deposited in the Library of Congress, Approved March 2, 1867.

A primary object of this movement was to secure as regularly and economically as possible all reports and other documents relative to the legislation, jurisprudence, statistics, internal economy, technology, &c., of all nations, so as to place the material at the command of the committees and members of Congress, heads of bureaus, &c.

No appropriation was made for meeting the necessary expenses, which could not conveniently be borne by the Smithsonian fund. But as a year would necessarily elapse before any documents would be ready for distribution, the following circular was issued by the Institution, with a view of ascertaining what governments would enter into the proposed arrangement:

CIRCULAR RELATIVE TO EXCHANGES OF GOVERNMENT DOCUMENTS.

Smithsonian Institution,  
Washington, U. S. A., May 16, 1867.

A law has just been passed by the Congress of the United States authorizing the exchange, under direction of the Smithsonian Institution, of a certain number of all United States official documents for the cor-

responding publications of other governments throughout the world, the returns to be placed in the national library at Washington. The works to be distributed under this law will consist of reports and proceedings of Congress, messages of the President, annual reports and occasional publications of departments and bureaus, &c., the whole relating to the legislation, jurisprudence, foreign relations, commerce, statistics, arts, manufactures, agriculture, geography, hydrography, &c., of the United States, and including everything of whatever nature published either by direct order of Congress or by any of the departments of the government. The series will embrace a large number of volumes each year, the most of which are bound.

The object of the law above mentioned is to procure for the use of the Congress of the United States a complete series of the publications of other governments, to include the documents of special bureaus or departments, as well as the general publications, of whatever nature, printed at the public expense, and also embracing all such works as are published by booksellers with the aid of grants or subscriptions from governments. The law is not retrospective, although it may cover some of the publications of the last session of Congress.

Some time will necessarily elapse before the first transmission can be made, but in order to organize a plan of exchange, to be presented for consideration to the Library Committee and the Librarian of Congress, I beg leave to ask your advice as to the best method of accomplishing the objects above stated. It is important to ascertain what governments are willing to enter into the proposed exchange, and whether any one bureau or branch of government or public library in each country will undertake to collect all the national publications, as above mentioned, and transmit them to Washington, or whether separate arrangements must be made with more than one office. The former plan is considered preferable, as diminishing the labor involved, and may possibly be adopted by enactment, as has been done by the United States. Whatever method be most feasible, you will confer a favor by giving us such information on these and other points as may serve for our guidance in further action.

Information is also desired as to the titles and character of the regular official publications of each country, and their average number and extent in each year, as well as the names of the different bureaus and officers from which they emanate.

The Smithsonian Institution, in behalf of the Library of Congress, is prepared to promise, if necessary, the delivery of the above-mentioned publications free of charge for freight. It will also name an agent in each country who will receive parcels or boxes containing the exchanges returned, and transmit them to Washington.

Besides the exchange of complete series of national publications, the law of Congress above stated authorizes the distribution of works on special subjects to the different bureaus having them in charge, as

finance, statistics, patents, agriculture, &c., provided that copies of their publications be given in return.

Very respectfully, your obedient servant,

JOSEPH HENRY,

*Secretary of Smithsonian Institution.*

[The Smithsonian Institution to the State Department.]

Smithsonian Institution, Washington, June 4, 1867.

HON. WILLIAM. H. SEWARD,

*Secretary of State:*

SIR: I have the honor to send, herewith, copies of a printed circular relative to an international exchange of public documents, for the benefit of the Congressional Library, with the request that you will transmit the same to all the diplomatic representatives of the United States in foreign countries, and, if favorable, to foreign ministers accredited to the United States.

Yours, respectfully,

JOSEPH HENRY.

[The State Department to the Smithsonian Institution.]

Department of State, Washington, June 18, 1867.

Prof. JOSEPH HENRY,

*Secretary to the Smithsonian Institution:*

SIR: I have to acknowledge the receipt of your letter of the 4th instant, inclosing copies of a printed circular relative to the international exchange of public documents for the benefit of the Congressional Library, and to inform you in reply that your request in regard to the distribution of the circulars has been complied with, they having been transmitted to foreign ministers here and to our ministers abroad.

Most truly yours,

WILLIAM H. SEWARD.

The honorable Secretary of State having thus courteously undertaken the official distribution of the Smithsonian circular to the representatives of foreign governments, formal recognitions were received from these powers, a majority of whom signified their approval and acceptance of the proffer. The following is a list of governments which responded favorably to the proposed international exchange of official documents:

Argentine Republic.  
Baden.  
Belgium.  
Chili.  
Colombia (United States of).  
Costa Rica.  
Denmark.  
Finland.  
France.

Great Britain.  
Hamburg.  
Netherlands.  
Norway.  
Spain.  
Sweden.  
Switzerland.  
Victoria.  
Wurtemberg.

These all embraced the opportunity offered of procuring the national publications of the United States, and proffered complete series of their own in return. Some of them, indeed, sent at once large packages of their works without awaiting further action on the part of our government. Among them one large box of books from the government of Victoria, Australia, was received, and its contents deposited in the Library of Congress.

Of the communications on this subject received either directly or through the Department of State, the greater number are herewith subjoined.

[The State Department to the Smithsonian Institution.]

Department of State, Washington, July 19, 1867.

Prof. JOSEPH HENRY,

*Secretary of the Smithsonian Institution:*

SIR: Herewith I inclose an extract of a dispatch of the 1st instant, from George N. Yeaman, esq., minister resident at Copenhagen, which relates to the exchange of public documents with the Government of Denmark, as proposed in your circular of the 16th of May last.

I am, sir, your obedient servant,  
WILLIAM H. SEWARD.

[*Inclosure.*]

No. 77.]

Legation of the United States,  
Copenhagen, July 1, 1867.

Hon. WM. H. SEWARD,

*Secretary of State, Washington:*

SIR: I have further to acknowledge the receipt of your circular dispatch of the 13th June, touching the subject of Professor Henry's circular, in relation to the exchange of official documents with foreign countries, and to state that Mr. Vedel, the director-general of the ministry of foreign affairs, with whom I have conversed upon the subject, and with whom I left a copy of Professor Henry's circular, has expressed himself gratified with the proposal, and suggests that for the present anything of interest he may have for the United States shall be left with me for shipment, and that United States documents might also be addressed to me for the Danish Government.

If other arrangements are deemed more convenient, hereafter they will be made.

Very respectfully, your obedient servant,  
GEORGE H. YEAMAN.



[The Argentine Legation to the Smithsonian Institution.]

Argentine Legation in the United States,  
10 University place, New York, August 17, 1867.

Prof. JOSEPH HENRY, Esq.,

*Secretary of the Smithsonian Institution, Washington:*

SIR: Upon my return from Washington I found a note from the Secretary of State inclosing your memorandum relating to an exchange of official documents of the United States for those of other countries. In fulfillment of the desires of the honorable Secretary and of those who direct that Institution I will hasten to communicate to my government the contents of those documents.

\* \* \* \* \*

Hoping soon to have the pleasure of presenting my respects in person to you in that city,

I remain, very respectfully, your obedient servant,  
B. MITRE Y VEDIA,  
*Chargé d'Affaires.*

[The State Department to the Smithsonian Institution.]

Department of State, Washington, August 23, 1867.

Prof. JOSEPH HENRY, &c., &c., *Smithsonian Institution:*

SIR: I inclose herewith, for your information, a copy of a note of the 19th instant, from the minister of Spain, in regard to the conclusion arrived at by Her Majesty's Government for the interchange of official publications between that government and the United States.

I am, sir, your obedient servant,  
WILLIAM H. SEWARD.

[Inclosure.—Translation.]

No. 27.]

Legation of Spain at Washington,  
Washington, August 19, 1867.

HON. SECRETARY OF STATE of the United States, &c., &c., &c.:

The undersigned, envoy extraordinary and minister plenipotentiary of Her Catholic Majesty, communicates to the honorable Secretary of State that, having submitted to the Government of Her Majesty the advantage of establishing a mutual interchange of official publications between Spain and the United States, with reference to the bases set out in the printed memorandum of Prof. Joseph Henry, Secretary of the Smithsonian Institution, has now received an answer on that point.

The Government of Her Catholic Majesty accepts with much pleasure the proposal for an exchange of documents, and is ready to deliver to the legation of the United States at Madrid, or to the agency that may

be designated, all the official publications of importance that may be brought out in Spain.

The undersigned avails of this opportunity to renew to the honorable Mr. Seward the assurance of his most distinguished consideration.

FACUNDO GOÑI.

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[The U. S. Legation at Switzerland to the Smithsonian Institution.]

Berne, September 21, 1867.

Prof. JOSEPH HENRY,

*Secretary of the Smithsonian Institution, Washington :*

SIR: Under instructions from Mr. Seward, transmitting to me your circular relative to an international exchange of national publications, I have communicated with "the proper authority"—that is, the chief of the department of the interior—designated by the high federal council as its agent" to arrange the mode of proceeding in the execution of the plan."

As the result of our conferences I am authorized to say to you that the high federal council accepts with great pleasure the proposition for the exchange of national publications.

It is desired to know whether you prefer to receive these publications as made and at the time of issue, or whether, at the end of each year, all the publications made during the year shall be delivered together in one or more packages.

It is preferred by the federal council that the publications shall be received and delivered at Berne by an agent of the Smithsonian Institution. I suggest that this legation be designated as such agent to receive and deliver such exchanges, which arrangement would be more acceptable to the Swiss Government than the agency of any private party.

The number and bulk of the federal publications will be small in comparison with ours, and the question was propounded whether the propositions also embraced *necessarily* the publications of each canton, as that would be somewhat difficult. I presume that, while such publications would be acceptable to you, it was not contemplated to include those of the cantonal governments.

For every reason I advise you to receive the publications of each year *en masse*, in lieu of receiving them in detachments.

The Swiss publications will be delivered packed ready for transportation.

I can only add that I stand ready to act in the premises as you may desire.

Very respectfully, your obedient servant,  
GEO. HARRINGTON.

[The State Department to the Smithsonian Institution.]

Department of State, Washington, October 2, 1867.

JOSEPH HENRY, Esq.,

*Secretary of the Smithsonian Institution :*

SIR: With reference to a memorandum from you which was communicated to Mr. A. Marzel on the 14th of June last, proposing an exchange of official publications of the United States for those of the Netherlands, I have now the honor to inclose a translation of a note of the 30th ultimo from Mr. A. Marzel, signifying a disposition on the part of the Netherlands Government to adopt the reciprocal arrangement proposed by you.

I am, sir, your very obedient servant,  
WILLIAM H. SEWARD.

[Inclosure—Translation.]

Legation of the Netherlands, September 30, 1867.

Hon. WILLIAM H. SEWARD, &c., &c., &c. :

SIR: Referring to my dispatch of the 15th of June last, in relation to an exchange of official documents between the United States and other countries, I now have the honor to inform you that the Government of the Netherlands is disposed to accede to the wish of the Secretary of the Smithsonian Institution in reference to the said exchange.

The different departments of the public administration having been consulted on the subject, they have unanimously applauded the idea suggested by Prof. Joseph Henry.

All that is needed now is an agent of the United States, appointed for the purpose, to be put in communication with the competent Netherlands authorities to carry out the proposed exchange in a regular manner.

I take the occasion to offer the assurance of my distinguished consideration.

A. MARZEL.

[The State Department to the Smithsonian Institution.]

Department of State, Washington, October 24, 1867.

Prof. JOSEPH HENRY,

*Secretary of the Smithsonian Institution, Washington :*

SIR: With reference to the correspondence which has taken place between us heretofore on the subject, I have the honor to inclose a copy of a communication of the 22 instant from Francis Clare Ford, esq., the chargé d'affaires *ad interim* of Great Britain, in relation to the proposed exchange of the official publications of the two countries.

I have the honor to be your obedient servant,  
WILLIAM H. SEWARD.

[Inclosure.]

Washington, October 22, 1867.

SIR: With reference to your note of the 13th of June, addressed to the late Sir Frederick Bruce, inclosing a memorandum of Prof. Joseph Henry, Secretary of the Smithsonian Institution, relative to an exchange of United States official documents for those of other countries, I have the honor to inform you that, the subject having been duly brought to the notice of my government, I have been instructed by Lord Stanley, Her Majesty's principal secretary of state for foreign affairs, to communicate to you the suggestions which have been made by the lords commissioners of Her Majesty's treasury in regard to the manner in which the proposed exchange should be carried out.

The lords commissioner of Her Majesty's treasury readily acknowledge the advantages of an exchange of copies of official documents between Her Majesty's Government and that of the United States, and are quite ready to give effect to the act of Congress referred to in the memorandum of Professor Henry, which was inclosed in your note of June 13. They suggest that the list of official documents prepared by the comptroller of the stationery office (a copy of which is herein inclosed) should be transmitted to you for the information of the Government of the United States, with an intimation that they will be prepared to give directions that a copy of the books therein enumerated, or any other official documents which may be named, shall be delivered to the agent of the United States, and that Her Majesty's minister at Washington be requested to obtain from the Government of the United States a list of corresponding official publications.

The lords commissioners of Her Majesty's treasury have, however, ascertained from the British admiralty that copies of the charts and publications of that department are already sent, annually, to the secretary of the United States Coast Survey and the Bureau of Navigation, and selections to the Secretary of the Smithsonian Institution.

I have the honor to be, with the highest consideration,

sir, your most obedient, humble servant,  
FRANCIS CLARE FORD.

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[The Government of Colombia to the U. S. Legation.]

[Translation.]

Department of the Interior and Foreign Relations,

Bogota, November 7, 1867.

To Hon. General PETER J. SULLIVAN,

*Minister Resident of the United States of America, &c.:*

SIR: In due time I had the honor of receiving your excellency's very attentive communication inclosing a letter from Mr. Joseph Henry, of S. Mis. 109—48

the Smithsonian Institution, dated the 16th of May last, in which he solicits, on the most liberal conditions, the exchange of the official (history) productions of this country for those of the United States of America.

The Government of Colombia, which sincerely desires to promote the interests of its countrymen, heartily adopts the plan of exchange which Mr. Henry of the Smithsonian Institution proposes through his excellency, and accepts it with greater satisfaction inasmuch as the official productions of the American Government, as Republican and enlightened, will be a worthy example for the citizens of Colombia, a country that is making every effort in its power to establish a free and just government.

The national librarian has been ordered by this department to make a detailed report as to the best manner of carrying into effect this exchange. As soon as it is received in this office, I will forward it to his excellency that he may transmit it to Mr. Henry as he requests.

And thus have the honor to offer to his excellency the assurance of my high and distinguished consideration.

CARLOS MARTIN.

[The Royal Library of Württemberg to the Smithsonian Institution.]

Stuttgart, November 11, 1867.

Mr. JOSEPH HENRY,

*Secretary Smithsonian Institution:*

DEAR SIR: In regard to the proposed exchange of government publications, we have the honor to submit the following answer to your communication.

Having inquired of all the bureaus issuing official publications, we are enabled to say that our government will readily enter into the proposed arrangement.

The Royal Public Library will undertake the collection and transmission of all the publications of our national institutions, thinking that arrangement would be more agreeable to both parties.

\* \* \* \* \*

We are well aware that the publications of our government, ordinary and extraordinary, will not bear comparison either in size or value with those of the Government of the United States; but since the offer of exchange proceeds from them we are glad to show our estimation of it by accepting it readily.

With regard to transmission, we think that a mutual delivery at Leipzig free of charge would be consistent with the ordinary terms of intercourse between the public libraries of Europe and America.

\* \* \* \* \*

Very respectfully, your obedient servant,

STÄELIN,

*Head Librarian of the Royal Public Library.*

[The State Department to the Smithsonian Institution.]

Department of State, Washington, November 14, 1867.

Prof. JOSEPH HENRY,

*Secretary of the Smithsonian Institution:*

SIR: Herewith I inclose for your information a transcript of a communication of the 21st ultimo, from the United States minister at Brussels, relative to an exchange of public documents with the Government of Belgium.

I am, sir, your obedient servant,  
WILLIAM H. SEWARD.

[Inclosure No. 1.]

No. 464.]

Legation of the United States,  
Brussels, October 21, 1867.

Hon. WILLIAM H. SEWARD,

*Secretary of State, &c., &c., &c.:*

SIR: With reference to your circular dispatch of 13th June relative to an exchange of public documents with this government, I have the honor herewith to inclose in translation copy of a communication from Mr. Rogier expressing the concurrence of the government in the proposition, and inclosing a first list of documents which it is proposed to forward by the end of the year, to be followed by others semi-annually.

I also inclose copy of my reply accepting the arrangement proposed.

The documents to be sent in exchange on our side can be forwarded, I presume, through the Belgian legation at Washington.

I have the honor to be, with great respect,  
Your most obedient servant,  
H. S. SANFORD.

[Inclosure No. 2.—Translation.]

Brussels, October 17, 1867.

Mr. SANFORD,

*Minister, &c., &c., &c., Brussels:*

MR. MINISTER: I have communicated to the minister of the interior the contents of the letter you were pleased to address me on the 5th of July last, respecting the proposal of an exchange of documents between our two governments.

My colleague is quite ready, Mr. Minister, to offer the Government of the United States of America a copy of the various official publications brought to light by the cares of his department. He has moreover, in accordance with the desire I had expressed to him, communicated the proposal in question to the other ministerial departments. The minister of finance has already declared that he is quite willing to give his adhesion thereto. I am persuaded that a similar statement will be made by my colleagues of the war, justice, and public works departments.

The best method to adopt with the view to secure the regular and collective dispatching of Belgian publications would be, seemingly, to collect them at the "science and letters division" of the ministry of the interior, so as to form the object of yearly or half yearly communication to the legation of the United States at Brussels, through the medium of my department.

I join to my letter, Mr. Minister, a provisional list of documents that could be placed at the disposal of the Government of the United States. The departments of foreign affairs will add a few publications enumerated at the end of this list. Should you have no objection, Mr. Minister, to make to the disposition intended to be taken, a first supply of works might be prepared before the end of the year.

The letter of the Minister of the Interior concludes as follows:

"As far as public instruction is concerned the exchange proposed has already been made the object of a direct communication from Mr. Sanford, dated May 27 last. Mr. Sanford was informed, in reply, that the United States must be in possession of the laws, decrees, and other documents relating to that service; that, in fact, the department of the interior has transmitted two copies of them to the legation at the time of their publication with request to be so kind as to forward one to the United States Government. The documents alluded to are the triennial reports in the three degrees of instruction. They contain everything connected with public teaching in our country. Mr. Sanford has been informed, besides, that, if he wished for it, another collection of these documents, as complete as possible, would be forwarded to him."

The only thing requisite in this respect would therefore be to act in conformity with precedents.

Please to receive, Mr. Minister, the assurance of my most distinguished consideration.

For the minister—Mr. ROGIER,

The Secretary-General, Baron LAMBERMONT.

[Inclosure No. 3.]

Legation of the United States, Brussels, October 19, 1867.

His Excellency Monsieur ROGIER,

*Minister of Foreign Affairs, &c., &c., &c.:*

MR. MINISTER: I have the honor to acknowledge the receipt of your excellency's letter, under date of 17th instant, relative to the proposition made in my communication of the 5th of July last, for an exchange of public documents.

I thank you, Mr. Minister, for the interest you have been pleased to manifest on this subject, and I shall have great satisfaction in receiving and transmitting to my government the documents as proposed in your letter, and at such times as will be most convenient to your excellency's department.

The documents referred to in the letter of his excellency the minister of the interior were specially designed for the Bureau of Educa-

tion at Washington. The triennial reports on public instruction periodically sent to this legation by your colleague of the department of the interior have been duly transmitted to my government, and duplicates of these copies will not, therefore, be needed.

Thanking you again, Mr. Minister, for your courteous and liberal response to the suggestion of exchange of public documents,

I pray your excellency to receive the renewed assurance of my highest consideration.

H. S. SANFORD.

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Department of State, Washington, December 11, 1867.

Prof. JOSEPH HENRY,

*Secretary of the Smithsonian Institution :*

SIR: Referring to your circular of the 16th of May last, in regard to the proposed exchange of a certain number of all official documents of the United States for the corresponding publications of foreign governments, I inclose for your information the translation of a note upon the subject which Mr. Berthemy, the French minister here, has addressed to the Department.

I am, sir, your obedient servant,  
WILLIAM H. SEWARD.

[*Inclosure.*—Translation.]

Legation of France to the United States,  
Washington, November 15, 1867.

Hon. WILLIAM H. SEWARD:

MR. SECRETARY OF STATE: In conformity with the wish you did me the honor to express to me in your letter of 13th of June last, I hastened to transmit to the imperial government, in commending it to attention, a circular from Prof. J. Henry of the Smithsonian Institution concerning an exchange of documents of official character, edited in the United States,—for publications of a similar kind printed by order, and with the concurrence of foreign governments.

In reply to the communication which was addressed to him on this subject by the minister for foreign affairs, the minister of agriculture, commerce, and public works has made known to the Marquis de Monstier that he could give of what pertains to his department his assent to the project for exchange, and could dispose of publications relating to general statistics of France, and to special statistics of railroads, as well as of reports made on the labors of engineers of mines, of annals of commerce with foreign countries and some analogous documents.

The minister for foreign affairs has charged me to bring this communication to your knowledge, and to add that the French administration would take the measures necessary to effect the exchange in question, either through the medium of the legation of the United States at Paris or through my intervention, as soon as it be known what are the



documents which the Secretary of the Smithsonian Institution is authorized to send to France.

Accept, Mr. Secretary of State, the assurance, of my high consideration.

BERTHEMY.

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[The State Department to the Smithsonian Institution.]

Department of State, Washington, January 21, 1868.

Prof. JOSEPH HENRY,

*Secretary of the Smithsonian Institution:*

SIR: For your information, I inclose herewith a transcript of a dispatch of the 19th ultimo, from the United States minister at Copenhagen, relative to the proposed exchange of public documents between the United States and European governments.

I am, sir, your obedient servant,  
WILLIAM H. SEWARD.

[Inclosure.]

No. 122.]

Legation of the United States,  
Copenhagen, December 19, 1867.

Hon. WILLIAM H. SEWARD,

*Secretary of State:*

SIR: Recurring to the circular of the Department and to that of Professor Henry, of the Smithsonian Institution, touching an exchange of documents, books, and publications with European governments, I have now to add that Count Friss, in a note to me of the 17th of this month, informs me that the Danish Government has charged the "Royal Library of Copenhagen" with the execution of the arrangement on the part of this government, and he suggests that the Smithsonian Institution select an agent in this city to carry the interchange into effect by receiving and forwarding the books, &c. For the Department and the Smithsonian Institution I have expressed satisfaction with this arrangement, and I cannot now think of a better local agent here than Mr. L. A. Heckoher, the United States vice-consul, who, I have no doubt, would act, and who is an intelligent, prompt, and careful business man. I have already forwarded one valuable scientific work to Professor Henry, in the care of Mr. Bille, chargé d'affaires.

I am, sir, very respectfully, your obedient servant,  
GEORGE H. YEAMAN.

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[The State Department to the Smithsonian Institution.]

Department of State, Washington, February 7, 1868.

Prof. JOSEPH HENRY,

*Secretary of the Smithsonian Institution, Washington:*

SIR: I have the honor to inclose, for your information, a copy in translation of a note of the 23d ultimo addressed to this Department by Mr.

Bille, chargé d'affaires of Denmark, and a copy of a note of the 25th ultimo from Baron de Wetterstedt, the Swedish and Norwegian minister, both referring to your proposed exchange of official documents between the Governments of Denmark and Sweden and Norway and the Government of the United States.

I am, sir, your obedient servant,  
WILLIAM H. SEWARD.

[*Inclosure No 1.—Translation.*]

Legation of Denmark, Washington, January 23, 1868.

Hon. WILLIAM H. SEWARD,  
*Secretary of State:*

SIR: The Royal Government has charged me to communicate to you that it is happy to give its adhesion to the exchange of official documents which during last year was proposed to it by the Government of the United States, and of which the Smithsonian Institution at Washington would serve as intermediary according to the organization planned in the letter of Mr. Henry, Secretary of the Smithsonian Institution, dated May 16, 1867.

I have the honor to add that the Grand Royal Library of Copenhagen is in charge, from this time, of all matters connected with such interchange, and that the different branches of the Danish administration will place subject to the direction of the library the publications they may wish to offer to the Government of the United States.

In consequence, and referring to the letter above mentioned from Mr. Henry, I venture to ask you, Mr. Secretary of State, to please inform me who is the agent of the Smithsonian Institution who will, at Copenhagen, be in charge of the packages intended for exchange with Denmark.

Please accept, Mr. Secretary of State, the assurances of my highest consideration.

F. BILLE.

[*Inclosure No. 2.—Translation.*]

Legation of Sweden and Norway,  
Washington, January 25, 1868.

Hon. WILLIAM H. SEWARD,  
*Secretary of State:*

SIR: Referring to my note of 19th June last year, in reply to yours of 13th same month, concerning a proposed exchange of official documents, I have the honor to inclose copy of an official letter, received from the Norwegian department of the interior, under date 19th ultimo, in which the acceptance by Norway of the offer of exchange is made known, and to request you kindly to bring the contents of the letter to the notice of the Secretary of the Smithsonian Institution.

I have the honor to be, with high consideration,  
Sir, your obedient servant,  
N. W. DE WETTERSTEDT.

[Translation of an official letter from the Royal Norwegian Department of the Interior to His Swedish and Norwegian Majesty's minister at Washington, dated Christiana, December 19, 1867.]

Under date June 18, last year, you forwarded to this department transcript of a note from the State Department at Washington, and a printed copy of a memorandum containing a proposition to establish a system of exchange of printed official documents, &c., between the United States of America and other countries, under the direction, on the American side, of the Smithsonian Institution at Washington.

In reply, the department will not fail to notify you, that the proposition is readily accepted from the Norwegian side, and that proper measures have been taken to the end that the exchange may take place from here in connection with the literary transmissions from the University of Christiana under the direction of the secretary of the university.

You are requested to bring the above to the knowledge of the proper authority at Washington, and also to co-operate to the end that the Smithsonian Institution may, in conformity with the offer made in the memorandum, appoint an agent here in Christiana, by whom the Norwegian documents may be received for further transmission to Washington.

BRETTEVILLE.  
N. BONNEVIE.

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[The State Department to the Smithsonian Institution.]

Department of State, Washington, February 8, 1868.

Prof. JOSEPH HENRY,

*Smithsonian Institution:*

SIR: I have the honor to inclose to you a copy of a communication received by Alvin P. Hovey, esq., minister resident at Lima, Peru, from the minister for foreign affairs of that Republic in reply to Mr. Hovey's note informing him of your proposition for an exchange of public documents.

I shall be pleased to receive such suggestions as you may deem it proper to make, so as to enable me to reply to Mr. Hovey on the subject.

I am, sir, your obedient servant,  
WILLIAM H. SEWARD.

[Inclosure No. 1.—Translation.]

No. 58.]

Foreign Office, Lima, December 30, 1867.

His Excellency the MINISTER OF THE UNITED STATES:

The esteemed note of your excellency, No. 54, was received at this office, inclosing a proposition from the Smithsonian Institution of Washington, sent to your excellency by the Department of State proposing an exchange of the official documents of that Republic for those of this.

I must mention to your excellency that the note referred to would

have been long ago answered, but it was received just previous to your excellency's departure for Chili.

I also desire to thank the Government of the United States through your excellency for the kind offer made to the Government of Peru.

The Government of Peru accepts with pleasure the proposition of your excellency's government, and I have the honor to inclose a copy of the decree issued by the President of Peru in relation to the matter.

The government proposes to organize the exchange in the following manner:

1. In the foreign office of Peru will be collected the different publications and documents requisite for the exchange.

2. To insure regularity in the exchange, the Government of Peru will send its publications to its consul in New York; and the Institution will send those it may desire to remit to the consul of the United States at Callao. By these two officers the documents will be forwarded to their destination.

3. It is deemed convenient that the exchange should commence from the beginning of the present year, 1868; but if the Institution thinks proper, any publications issued before that date will readily be exchanged.

4. With respect to the nature of the publications to be exchanged, I beg to call your excellency's attention to the inclosed list. If the Institution approves, the Peruvian Government will send the works contained in the first series, and afterward will continue sending each year, a copy of the works contained in the second series, receiving in exchange the corresponding publications issued in the United States.

I beg that your excellency will transmit to the Institution these bases, and communicate the reply to this department, so that if the reply be favorable, the Peruvian Government may immediately commence its part in this arrangement.

I beg to assure your excellency of my most distinguished consideration.

I. A. BARRENECHEA.

[Inclosure No. 2.—Translation.]

Lima, December 27, 1867.

Having seen the note of his excellency the minister of the United States of America, and the adjoined circular of the Smithsonian Institution of Washington, proposing an exchange of the official documents of Peru for those of the United States, the proposal is accepted in all of its terms.

Let the corresponding orders be given.

To be registered, communicated, and published.

Rubric of His Excellency the President.

I. A. BARRENECHEA.

Copy.

I. FEDERICO ELMORE,  
*Chief Clerk.*

[The U. S. Legation at China to the Smithsonian Institution.]

Legation of the United States, Peking, April 17, 1868.

Prof. JOSEPH HENRY,

*Secretary of Smithsonian Institution:*

SIR: A circular from you, dated May 16, 1867, respecting the best method of carrying out the provisions of the law of Congress authorizing the exchange of United States official documents for those of other countries, was received through the Department of State last year. It was only recently, however, that I found a convenient opportunity of ascertaining the views of the Chinese officials upon the proposal. The inclosed correspondence exhibits their views, but in addition to the statements made in my letter, the purposes, advantages, and results of the exchange were personally explained to Tung Siun, the most learned and literary member of the foreign office, whose name is perhaps already known to you for his version into Chinese of Longfellow's Psalm of Life. He entered into the plan with entire readiness, but stated that its adoption rested with another department of government from the one he belonged to, and might not therefore immediately be accepted.

The Chinese Government has from time to time published or aided works of value, but it issues nothing like our reports of departments, nor has it any official organ for making known its operations, decrees, or appointments. The Red Book, or quarterly official list of incumbents in the civil and military service, and the Peking Gazette, are both allowed to be published under its sanction by private persons, who never add anything to the papers furnished them, but the Calendar is, so far as I know, the only authorized publication issued by any branch of the government. The three last Emperors have not equaled their predecessors in their patronage of letters, and if an exchange of a suitable selection of the books printed by order of Congress can, by and by, be made for some of the statistical and political works of former monarchs, the result would no doubt be mutually advantageous.

The United Learning College, of which mention is made in the correspondence, if it succeeds in carrying out the designs of its founders, will, in a few years, educate natives who will be able to turn the information given in our books to good account. At present, I do not think that there are a score of Chinese in the whole country who are able to fully understand them, but it is even more probable that there is not half that number of persons in the United States (not including Chinese) who could intelligently consult the works which this government might send to you in exchange. It is perhaps best then not to press the subject at present.

I am, sir, with esteem,

Very respectfully your obedient servant,  
S. WELLS WILLIAMS.

[The Indian Survey Office to the Smithsonian Institution.]

No. 131.]

Geological Survey Office,  
Calcutta, October 26, 1868.

Professor HENRY,

*Secretary Smithsonian Institution, Washington:*

DEAR SIR: In the last packet of books received by me from the Smithsonian Institution I found a printed notice proposing to establish, through the agency of the Smithsonian Institution, a system of exchange of the various public documents printed and issued under the sanction of the Government of the United States, for similar documents issued by other governments.

I at once submitted this proposal to the secretary to the Government of India, expressing a hope that the proposition might be favorably received. And I am now instructed to inform you that the Government of India will be happy at once to enter upon a system of reciprocal exchange of their public documents with the Government of the United States, through your Institution.

I have further the pleasure to inclose to you a list of such reports and other documents as are at the present available. It is possible also that some of the former numbers of those which have appeared in series can be obtained.

As soon as I shall have the pleasure of hearing from you, whether such a series will be acceptable, the books can be packed and forwarded to the Smithsonian Institution, as you may desire. Books for Calcutta should be forwarded direct by ship (the quickest way), or sent to London, to the care of the Secretary of State for India, India Office.

All parcels should be addressed to the Secretary to Government of India, Home Department, Calcutta.

I trust that both this country and the United States may long continue to reap the important advantages which must result from a free interchange of such documents relating to either country.

I have the honor to be, sir, your most obedient servant.

THOMAS OLDHAM,  
*Superintendent of the Geological Survey of India.*

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[The Government of Colombia to the State Department.]

Bogota, November —, 1869.

His Excellency the SECRETARY OF STATE  
*of the United States of America:*

The Colombian Government considers the exchange of their respective literary and scientific productions as an effective means of developing the civilization and wealth of nations, of drawing their mutual relations closer, and of rendering the same more fraternal.

Desiring to contribute to the attainment of an object which, for this country, is so important, the Government of the Union issued the decree of the 23d of January, 1868, "which establishes, in the national library, a central bureau for the exchange of the national publications for those of other American countries."

That your government may become acquainted with the provisions of said decree, the undersigned secretary of the interior and of foreign relations has the honor to send your excellency a copy of the same.

And as the executive power of the Union does not doubt that the project contained in this decree will be accepted by your excellency's government, it has ordered the box containing the first collection of Colombian publications, intended for your country, to be sent to the national administrator of finance at Santa Marta, to be held by him at the disposal of your government, or of its librarian. A list of these publications is given in the annexed note, addressed by the national librarian to the librarian of the United States of America.

The undersigned begs your excellency to obtain from the most excellent President of your Republic the adoption of this project, and the making of the necessary arrangements, that it may be carried out; and is happy to present you the assurances of the very distinguished consideration with which he has the honor to be,

Your excellency's obedient servant,  
ANTO. M. PRADILLO.

[Inclosure.—Translation.]

DECREE ESTABLISHING, IN THE NATIONAL LIBRARY, A CENTRAL OFFICE FOR THE EXCHANGE OF THE NATIONAL PUBLICATIONS WITH THOSE OF THE OTHER COUNTRIES OF AMERICA.

The President of the United States of Colombia, considering—

1st. That the literary and scientific works of the nation are very little known and circulated outside of the country, on account of the lack of relations established for this purpose;

2d. That the republics of the United States of America, Bolivia, and Chili have already initiated the establishment of such relations with the Colombian Union, and that it is not doubtful that the other American nations will gladly welcome the organization of exchanges of publications which may make us better known to each other; and

3d. That no means can more efficaciously contribute to the cause of enlightenment, and towards the fraternity of the nations of America, than the establishment of a literary and scientific correspondence among the different peoples, which would be the result of such exchanges—

DECREE.

*Article 1.* There is established in the national library, under charge of the librarian, a central office for the exchange of official publications

and of such literary and scientific works as the national government, the governments of the states of the Union, and private individuals, authors or publishers, may designate to be sent to other American countries, in exchange for their publications.

*Art. 2.* The national librarian shall enter, directly, into such negotiations or correspondence with the librarians of the other countries of America as may be necessary to establish the regular exchanges and literary relations which are the object of the present decree.

*Art. 3.* The national administration of finance in the state of Panama, and the Colombian Consuls-generals and private individuals in the nations of America, shall assist the national librarian in carrying out the projected exchanges, acting as intermediate agents, and promoting and facilitating said exchanges so far as it may be in their power to do so. The librarian may communicate directly, for the purposes indicated, with the consuls of Colombia, and with the administrator of national finance in Panama, and for the greater security of his letters to other countries, he may send them, if he shall think proper, through the department of the interior and of foreign relations.

*Art. 4.* There shall be placed at the disposal of the librarian twenty-five copies of each of the official publications of the country which shall hereafter appear, for the objects of this decree, and twenty-five copies of those now in the archives or in the national library, in order that he may remit the same, together with the invitation which he shall address to each one of the libraries of America, to establish exchanges.

*Art. 5.* The librarian shall propose to the executive the purchase of such non-official publications as he may deem suitable to be sent in exchange. If the executive shall think that the publications proposed ought to be purchased for said purpose, he shall issue an order to that effect, and the cost of the same shall be paid from the national contingent fund for "sundry expenses" of the department of the interior.

*Art. 6.* There shall be addressed by the department of the interior and of foreign relations, to the governments of America, a circular giving notice of the provisions of this decree, and calling their attention to the importance of their adopting the proper means to carry out the beneficent plan of establishing and systematizing our literary and scientific relations.

*Art. 7.* There shall likewise be addressed, by the same department, a circular to the governments of the Colombian states, urging them to aid in the execution of the provisions of this decree by all the means in their power.

*Art. 8.* The national librarian may extend the provisions of this decree to some of the libraries and establishments for the publication and sale of books in Europe.

*Art. 9.* All works which may be sent to this office in exchange for national publications shall be preserved in their respective places in



accordance with the prescriptions of the executive decree of the 21st instant, providing for the proper "arrangement of the national library."

Given at Bogota, January 23, 1868.

SANTOS ACOSTA,  
*President.*

CÁRLOS MARTIN,  
*Secretary of the Interior and of Foreign Relations.*

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[The National Library of Colombia to the Smithsonian Institution.]

[Translation.]

United States of Colombia, National Library,  
Central Office of Exchanges,  
Bogota, November 17, 1869.

Prof. JOSEPH HENRY,  
*Secretary of the Smithsonian Institution, Washington :*

In the month of November, 1867, the Hon. General Sullivan, who was then minister resident of the Union near our government, communicated to the latter the law passed by Congress authorizing the exchange of official publications for those of other countries, under the direction of the Smithsonian Institution. The Government of Colombia accepted, and furnished to the minister all the data which he had thought proper to ask, at the same time conferring on me the honor of designating me for the management of everything relating to the subject.

Subsequently, the national executive drew up the decree of the 23d of January, 1868, "establishing in the national library a central office of exchanges of the national publications for those of the other countries of America;" an authenticated copy of which decree I have the honor of herewith transmitting.

Authorized, therefore, as well by the commission, received from the government on the occasion named, as by the decree which I inclose, I take the liberty of addressing myself to you, now that the central bureau of exchanges is beginning to operate with all desirable regularity, having overcome the embarrassments and impediments incident to every office recently created, and which have hitherto delayed the official invitation which I have now the honor of submitting to you.

It is quite time that populations should be brought into contact, and that, for their mutual advancement, they should come to know one another by the initiation of literary relations. But, that this end might be satisfied and not remain a simple project, it was necessary that introductory measures should be taken by the government, giving at the same time greater security to the exchanges and encouraging private individuals to furnish their productions under the guarantee thus provided that they will be duly forwarded.

The noble object of the Smithsonian Institution absolves me from the necessity of troubling you with considerations relating to the utility and

convenience of the proposed exchanges, but inasmuch as an understanding should exist between us respecting the manner of verifying them, I submit to your consideration the proposition that the Government of Colombia should place the packages intended for remittance by the library in the port of Santa Marta, where they will be delivered by the administrator of the national property to the person whom you may be pleased to designate, and that the same national functionary shall receive at that port those which you may be so good as to send us. Desiring that, until this be possible, there should be a general basis for the exchange of publications, it seems to me equitable that this office should deliver and receive in our own sea-ports.

As a first remittance, I have the honor of dispatching a case containing 204 volumes, pamphlets, collections, &c., as will be found detailed in the annexed catalogue. Of some of these publications it has not been possible, for the moment, to send complete collections, but I have taken a note of the numbers or deliveries which are wanting, in order that they may be sent in subsequent remittances.

This case is directed to Santa Marta, to the care of the administrator of the national property. He will keep it in his own custody until you shall be pleased to give instructions respecting the person to whom it shall be delivered. For the next, I shall be guided by the directions which you may think proper to communicate to me, but in the present instance it seemed more convenient that you should directly instruct the administrator (*administrador de hacienda nacional*) as to the disposal of the case in question, with a view to save the time which would be lost by an exchange of notes.

It remains to be mentioned that a case, with like contents, is remitted, at the same date with the above, for the national library at Washington; so that the one in question is expressly destined for the Institution over which you preside as Secretary.

I am led to hope that the remittances will promptly be augmented, both in number and importance; but the honor will still inure to me of having exchanged with you the first notes on the inception of these literary relations, an honor which I prize the more highly from its affording me the occasion of expressing the respect and high consideration with which I am

Your very obedient servant,  
OTAVA,

*Librarian, and Director of Exchanges.*

In October, 1874, four cases of documents were sent to the Government of Ontario, Toronto; and in November, 1874, five cases to the Parliamentary Library, Ottawa; five cases to the Government of Japan, and four cases to the Bibliothek des Deutschen Reichstag, Berlin.

A number of boxes were also shipped to the agents of the Institution in Europe, to be held by them for further instructions.

A large quantity of these public documents having accumulated at the Institution, it became necessary to provide for their distribution without further delay, and accordingly the Institution issued, in 1875, the following circular:

Smithsonian Institution, Washington, October 1, 1875.

The Congress of the United States has authorized the exchange, under the direction of the Joint Library Committee of Congress, through the Smithsonian Institution, of a certain number of all United States official documents for the corresponding publications of other governments throughout the world, the returns to be placed in the national library at Washington. The works to be distributed consist of reports and proceedings of Congress, messages of the President, annual reports and occasional publications of departments and bureaus, &c., the whole relating to the legislation, jurisprudence, foreign relations, commerce, statistics, arts, manufactures, agriculture, geography, hydrography, &c., of the United States, and including everything, of whatever nature, published either by direct order of Congress or by any of the departments of the government. The series embraces a large number of volumes each year, the most of which are bound.

The exchange expected from each government is a complete series of its publications, to include the documents of special bureaus or departments as well as the general publications, of whatever nature, printed at the public expense, and also embracing all such works as are published by booksellers with the aid of grants or subscriptions from governments.

The Smithsonian Institution, in behalf of the Joint Library Committee of Congress, is prepared to deliver the publications of the United States, free of charge for freight, to any person in the city of Washington or in New York who may be designated by the governments which enter into the arrangement.

The books intended for the United States are to be delivered to either of the Smithsonian agents, viz:

*London*.—William Wesley, 28 Essex street, Strand.

*Paris*.—G. Bossange, 16 Rue du 4 Septembre.

*Leipsic*.—Dr. Felix Flügel, 12 Sidonien strasse.

*St. Petersburg*.—L. Watkins & Co., 10 Admiralty Place.

*Amsterdam*.—F. Müller, Heerengracht.

*Milan*.—U. Hoepli, 591 Galeria Cristoforia.

*Harlem*.—Bureau Scientifique Central Néerlandais.

*Christiania*.—Kongelige Norske Fredericks Universitetet.

*Stockholm*.—Kongeliga Svenska Vetenskaps Akademien.

*Copenhagen*.—Kongelige Danske Videnskabernes Selskab.

For all other countries packages may be delivered to the United States ministers. An invoice for each transmission should be sent by mail to the Institution.

JOSEPH HENRY,  
*Secretary of the Smithsonian Institution.*

This circular was sent with the following letter to the foreign ministers in Washington representing the following countries: Argentine Republic, Austria-Hungary, Belgium, Brazil, Chili, Denmark, France, German Empire, Great Britain, Guatemala, Hawaii, Hayti, Italy, Japan, Mexico, Netherlands, Peru, Portugal, Russia, Salvador, Spain, Sweden, Norway, Turkey, United States of Colombia, Venezuela:

Smithsonian Institution,  
Washington, D. C., October 30, 1875.

SIR: I have the honor, accompanying this, to transmit a circular relative to the exchange of the documents published by the United States with those of other nations, and to request you to state to whom the boxes now ready for transmission, intended for your government, shall be delivered.

Very respectfully, your obedient servant,  
JOSEPH HENRY,  
*Secretary of the Smithsonian Institution.*

In accordance with the instructions received by the Institution, in response to the foregoing letter, the following distribution of documents was made:

*Argentine Republic.*—Six cases, sent to G. Videla Dorna, Albemarle Hotel, New York.

*Belgium.*—Six cases, sent to Peter Wright & Sons, Philadelphia.

*Brazil.*—Six cases, sent to vice-consul, 52 South Gay street, Baltimore.

*Chili.*—Six cases, sent to Muñoz & Espriella, 52 Pine street, New York.

*France.*—Six cases, sent to consul-general of France, New York.

*Mexico.*—Six cases, sent to Juan N. Navarro, consul-general of Mexico, New York.

*Portugal.*—Six cases, sent to consul-general of Portugal, New York.

*Sweden.*—Six cases, sent to consulate, 18 Exchange Place, New York.

*Turkey.*—Six cases, sent to legation, Washington, D. C.

During the year 1876, 120 boxes of documents were forwarded, the following being a list of the distribution:

Places sent to.	Boxes.	Places sent to.	Boxes.
Belgium.....	1	Prussia.....	5
Brazil.....	1	Queensland.....	7
Buenos Ayres.....	7	Saxony.....	5
Canada.....	2	Scotland.....	7
Chili.....	1	Spain.....	5
England.....	5	South Australia.....	7
Germany.....	3	Sweden.....	7
Hayti.....	6	Switzerland.....	7
Holland.....	1	Tasmania.....	7
Japan.....	1	Turkey.....	1
Mexico.....	1	Venezuela.....	6
New South Wales.....	7	Victoria.....	7
New Zealand.....	7		
Norway.....	5	Total.....	120
Portugal.....	1		

[The State Department to the Smithsonian Institution.]

Department of State, Washington, D. C., May 29, 1876.  
 Prof. JOSEPH HENRY, &c., &c., &c. :

SIR: I herewith inclose a copy of a note, dated the 22d instant, which has been received from Sir Edward Thornton, the British minister at this capital, respecting the interchange of official documents between this country and Great Britain, wherein, referring to certain circulars on this subject received by him from you in November last, he inquires whether the Smithsonian Institution is acting in behalf of the Government of the United States in this matter.

I am, sir, your obedient servant,  
 HAMILTON FISH.

[Inclosure.—Sir E. Thornton to Mr. Fish.]

Washington, May 22, 1876.

Hon. HAMILTON FISH, &c., &c. :

SIR: I have the honor to inclose copies of two circulars which I received in November last from Professor Henry, Secretary of the Smithsonian Institution, relative to the exchange of official documents between the Governments of the United States and of Her Majesty. I forwarded copies of the circulars to Lord Derby, but as it does not appear that any formal arrangement has yet been made between the two governments for the general exchange of official documents, his lordship has directed me to inquire whether the Smithsonian Institution is acting on behalf of the Government of the United States. I shall have much pleasure in conferring with you upon this subject during my next visit to the State Department with a view to ascertain more precisely what would be the British official documents which the United States Government would desire to receive in exchange for those of this country.

I have the honor to be, with the highest consideration,  
 Sir, your obedient servant,  
 EDWARD THORNTON.

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[The Smithsonian Institution to the State Department.]

Smithsonian Institution, Washington, June 2, 1876.  
 Hon. HAMILTON FISH,  
*Secretary of State:*

DEAR SIR: I have the honor to acknowledge the receipt of your letter of the 29th ultimo, and the accompanying letter from Sir Edward Thornton, relative to the question whether the Smithsonian Institution is acting in behalf of the Government of the United States as agent in the exchange of public documents between the government of this country and that of Great Britain.

As a reply to this question I beg leave to refer you to the acts of Con-

gress approved by the President of the United States, March 2, 1867 (Stat., vol. xiv, p. 573); July 25, 1868 (Stat., vol. xv, p. 260); sec. 3796 Rev. Stat.

As to the question what official documents the United States Government desires to receive from Great Britain, I would say that as the United States Government intends to send a full set of everything that is printed at the government expense, a similar return would be expected of all documents published by the British Government.

I have the honor to be, very respectfully, your obedient servant,

JOSEPH HENRY,  
*Secretary of Smithsonian Institution.*

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[The State Department to the Smithsonian Institution.]

Department of State, Washington, March 23, 1877.

Prof. JOSEPH HENRY,  
*Washington, D. C., &c., &c., &c.:*

SIR: I inclose herewith, for your information, a copy of a dispatch of the 7th instant, No. 138, from Mr. Pierrepont, the minister for the United States at London, relating to the subject of international exchange of public documents.

I am, sir, your obedient servant,  
F. W. SEWARD,  
*Assistant Secretary.*

[*Inclosure.*]

No. 138.]

Legation of the United States,  
London, March 7, 1877.

Hon. HAMILTON FISH,  
*Secretary of State, &c., &c., &c., Washington, D. C.:*

SIR: I received sometime since from Professor Henry, of the Smithsonian Institution, a letter in relation to the international exchange of documents between the United States and Great Britain, and inclosing a circular upon the subject.

I was not able conveniently to bring the matter to the attention of Lord Derby until the 20th of October last, when I sent to him a copy of Dr. Henry's letter and circular, and requested him to refer the subject to the proper authorities.

He acknowledged the receipt of my communication on the 31st of October, but it was not until the 1st instant that I received from his lordship a definite answer to Dr. Henry's proposal, a copy of which answer I herewith inclose, and ask that you will do me the favor to communicate it to Dr. Henry.

I have the honor to be,  
With great respect, your obedient servant,  
EDWARDS PIERREPONT.

[*Inclosure.*]

[Lord Derby to Mr. Pierrepont.]

Foreign Office, March 1, 1877.

Hon. EDWARDS PIERREPONT, &amp;c., &amp;c., &amp;c.:

SIR: With reference to my letter of 31st of October last, I have the honor to acquaint you that the proposal of the Smithsonian Institution for an interchange of documents between the United States and this country has been considered by the lords of Her Majesty's treasury, and that they have informed me that they do not think it expedient to agree to an unlimited and indiscriminate exchange of papers, the greater part of which would be only of local and temporary interest.

Arrangements have been made for the purchase for Her Majesty's government of the Congressional documents issued from year to year, which appear to include all that is required for the use of this department.

I have accordingly the honor to request that you will be so good as to inform Professor Henry that Her Majesty is grateful for the offer made by the Smithsonian Institution, but are not prepared to enter into an arrangement for the unlimited interchange of documents suggested in his letter to you of the 21st of July last.

I have the honor to be, with the highest consideration,  
Sir, your most obedient, humble servant,

DERBY.

[Legation of Austria-Hungary to the Smithsonian Institution.]

Saratoga, July 31, 1878.

Professor S. F. BAIRD,

*Secretary of the Smithsonian Institution:*

SIR: In compliance with the wishes expressed by the imperial and royal minister of finances, I have the honor to transmit you herewith for the library of the Smithsonian Institution a complete file of the publications concerning various projects of law, presented by the Austro-Hungarian Government to the delegations of the Austro-Hungarian Empire during the session December 3, 1877—June 7, 1878, as well as of all the resolutions adopted by the said delegations and sanctioned hereafter by His Imperial and Royal Apostolic Majesty.

Receive, sir, the assurances of my very distinguished consideration,

TAVEREZ,

*Chargé d'Affaires of Austria-Hungary.*

Arrangements effected with most of the governments interested in the system of exchanges have resulted in instructions to their respective representatives in Washington to facilitate such operations officially; and accordingly their several consuls at New York and Baltimore now act as forwarding agents.

*Shipping agents of government exchange.*

Countries.	Agents.
Argentine Republic .....	Consul-General Carlos Carranza, New York.
Bavaria .....	North German Lloyd, Baltimore.
Belgium .....	White Cross Line and Red Star Line, New York.
Brazil .....	Consul Charles Mackall, Baltimore.
Buenos Ayres .....	Carlos Carranza, consul-general, New York.
Canada .....	Baltimore and Ohio Express Company.
Chili .....	Consul-General C. de Castro, New York.
Cuba .....	Consul-General Hipolito de Uriarte, New York.
Denmark .....	Consul-General Hénrick Braem, New York.
Ecuador .....	Consul Francis Spies, New York.
France .....	Compagnie Générale Transatlantique, New York.
Germany .....	North German Lloyd, Baltimore.
Great Britain .....	Do.
Greece .....	Consul-General D. W. Botassi, New York.
Guatemala .....	Consul Jacob Baez, New York.
Hayti .....	Atlas Steamship Company, New York.
Italy .....	Consul-General M. Raffo, New York.
Japan .....	Consul-General Samro Takaki, New York.
Mexico .....	Consul-General Juan N. Navarro, New York.
Netherlands .....	Consul-General R. C. Burlage, New York.
New South Wales .....	R. W. Cameron & Co., New York.
New Zealand .....	R. W. Cameron & Co., New York.
Norway .....	Consul-General Christian Börs, New York.
Portugal .....	Consul-General Gustav Amsink, New York.
Prussia .....	North German Lloyd, Baltimore.
Queensland .....	Do.
Russia .....	Hamburg American Packet Company, New York.
Saxony .....	North German Lloyd, Baltimore.
South Australia .....	R. W. Cameron & Co., New York.
Spain .....	Consul-General Hipolito de Uriarte, New York.
Sweden .....	Consul-General Christian Beers, New York.
Switzerland .....	North German Lloyd, Baltimore.
Tasmania .....	Do.
Turkey .....	Turkish legation, Washington, D. C.
Venezuela .....	Consul-General G. de Garmendia, New York.
Victoria .....	R. W. Cameron & Co., New York.
Württemberg .....	North German Lloyd, Baltimore.

*Governments in exchange with the United States Government.*

Governments.	Establishments designated for the reception of the United States Government publications.
Argentine Republic .....	Minister of Foreign Affairs, Buenos Ayres.
Bavaria .....	Königliche Bibliothek, Munich.
Belgium .....	Bibliothèque Royale, Brussels.
Brazil .....	Commission of International Exchange, Rio Janeiro.
Buenos Ayres .....	Government of Buenos Ayres, Buenos Ayres.
Canada .....	Parliamentary Library, Ottawa.
Chili .....	Legislative Library, Toronto.
Denmark .....	Museo Nacional, Santiago.
France .....	Kongelige Bibliothek, Copenhagen.
Germany .....	Government, Paris.
Great Britain .....	Reichstags Bibliothek, Berlin.
Greece .....	British Museum, London.
Hayti .....	Bibliothèque Nationale.
Italy .....	Secrétaire des relations extérieures, Port-au-Prince.
	Biblioteca Nazionale Vittorio Emanuele, Rome.



*Governments in exchange with the United States Government—Continued.*

Governments.	Establishments designated for the reception of the United States Government publications.
Japan .....	Minister of foreign affairs, Tokio.
Mexico .....	Government, Mexico.
Netherlands .....	Library of the States General, the Hague.
New South Wales .....	Parliamentary Library, Sydney.
New Zealand .....	Parliamentary Library, Wellington.
Norway .....	Foreign office, Christiania.
Portugal .....	Government, Lisbon.
Prussia .....	Königliche Bibliothek, Berlin.
Queensland .....	Government, Brisbane.
Russia .....	Commission des Echanges Internationaux, St. Petersburg.
Saxony .....	Königliche Bibliothek, Dresden.
South Australia .....	Government, Adelaide.
Spain .....	Government, Madrid.
Sweden .....	Government, Stockholm.
Switzerland .....	Eidgenossensche Bundes Canzley, Berne.
Tasmania .....	Parliamentary Library, Hobarton.
Turkey .....	Government, Constantinople.
Venezuela .....	University Library, Caracas.
Victoria .....	Public Library, Melbourne.
Württemberg .....	Königliche Bibliothek, Stuttgart.

*Transmissions of Government exchanges.*

Country.	Box A (1).	Box B (2).	Box C (3).	Box D (4).	Box E (5).
Argentine Republic .....	Nov. 18, 1876	Nov. 18, 1875	Nov. 18, 1875	Nov. 18, 1875	Nov. 18, 1875
Bavaria .....	Aug. 16, 1878	Aug. 16, 1878	Aug. 16, 1878	Aug. 16, 1878	Aug. 16, 1878
Belgium .....	Nov. 20, 1875	Nov. 20, 1875	Nov. 20, 1875	Nov. 20, 1875	Nov. 20, 1875
Brazil .....	Nov. 17, 1875	Nov. 17, 1875	Nov. 17, 1875	Nov. 17, 1875	Nov. 17, 1875
Buenos Ayres .....	Nov. 21, 1876	Nov. 21, 1876	Nov. 21, 1876	Nov. 21, 1876	Nov. 21, 1876
Canada (Ottawa) .....	Nov. 5, 1874	Nov. 5, 1874	Nov. 5, 1874	Nov. 5, 1874	Nov. 5, 1874
Canada (Toronto) .....	Oct. 10, 1874	Oct. 10, 1874	Oct. 10, 1874	Oct. 10, 1874	Dec. 13, 1875
Chili .....	June 18, 1875	June 18, 1875	Jan. 31, 1875	Jan. 31, 1875	Jan. 31, 1875
Denmark .....	Mar. 20, 1879	Mar. 20, 1879	Mar. 20, 1879	Mar. 20, 1879	Mar. 20, 1879
England .....	Sept. 11, 1876	Sept. 11, 1876	Sept. 11, 1876	Sept. 11, 1876	Sept. 11, 1876
France .....	Nov. 11, 1875	Nov. 11, 1875	Nov. 11, 1875	Nov. 11, 1875	Nov. 11, 1875
Second set .....	July 3, 1879	July 3, 1879	July 3, 1879	July 3, 1879	July 3, 1879
Germany .....	Oct. 8, 1874	Oct. 8, 1874	Oct. 8, 1874	Oct. 8, 1874	Aug. 7, 1876
Greece .....	Nov. 21, 1877	Nov. 21, 1877	Oct. 10, 1877	Oct. 10, 1877	Oct. 10, 1877
Havti .....	July 24, 1876	July 24, 1876	July 24, 1876	July 24, 1876	July 24, 1876
Holland .....	Dec. 14, 1875	Dec. 14, 1875	Dec. 14, 1875	Dec. 14, 1875	Dec. 14, 1875
Italy .....	Feb. 23, 1881	Feb. 23, 1881	Feb. 23, 1881	Feb. 23, 1881	Feb. 23, 1881
Japan .....	Nov. 2, 1874	Nov. 2, 1874	Nov. 2, 1874	Nov. 2, 1874	Nov. 2, 1874
Mexico .....	Dec. 1, 1875	Dec. 1, 1875	Dec. 1, 1875	Dec. 1, 1875	Dec. 1, 1875
New South Wales .....	July 30, 1876	July 30, 1876	July 30, 1876	July 30, 1876	July 30, 1876
New Zealand .....	do	do	do	do	do
Norway .....	June 18, 1873	June 18, 1873	Dec. 11, 1876	Dec. 11, 1876	Dec. 11, 1876
Portugal .....	Nov. 11, 1875	Nov. 11, 1875	Nov. 11, 1875	Nov. 11, 1875	Nov. 11, 1875
Prussia .....	Aug. 7, 1876	Aug. 7, 1876	Aug. 7, 1876	Aug. 7, 1876	Aug. 7, 1876
Queensland .....	June 9, 1876	June 9, 1876	June 9, 1876	June 9, 1876	June 9, 1876
Russia .....	Nov. 2, 1881	Nov. 2, 1881	Nov. 2, 1881	Nov. 2, 1881	Nov. 2, 1881
Saxony .....	Aug. 28, 1876	Aug. 28, 1876	Aug. 28, 1876	Aug. 28, 1876	Aug. 28, 1876
Scotland .....	Dec. 26, 1876	Dec. 26, 1876	Dec. 26, 1876	Dec. 26, 1876	Dec. 26, 1876
South Australia .....	July 3, 1876	July 3, 1876	July 3, 1876	July 3, 1876	July 3, 1876
Spain .....	Dec. 9, 1876	Dec. 9, 1876	Dec. 9, 1876	Dec. 9, 1876	Dec. 9, 1876
Sweden .....	Nov. 11, 1875	Nov. 11, 1875	Nov. 11, 1875	Nov. 11, 1875	Nov. 11, 1875
Switzerland .....	Oct. 31, 1876	Oct. 31, 1876	Oct. 31, 1876	Oct. 31, 1876	Oct. 31, 1876
Tasmania .....	July 15, 1876	July 15, 1876	July 15, 1876	July 15, 1876	July 15, 1876
Turkey .....	Nov. 9, 1875	Nov. 9, 1875	Nov. 9, 1875	Nov. 9, 1875	Nov. 9, 1875
Venezuela .....	July 24, 1876	July 24, 1876	July 24, 1876	July 24, 1876	July 24, 1876
Victoria .....	June 9, 1876	June 9, 1876	June 9, 1876	June 9, 1876	June 9, 1876
Württemberg .....	Jan. 28, 1879	Jan. 28, 1879	Jan. 28, 1879	Jan. 28, 1879	Jan. 28, 1879

*Transmissions of Government exchanges—Continued.*

Country.	Box F (6).	Box G (7).	Box H (8).	Box I (9).	Box K (10).
Argentine Republic .....	Nov. 18, 1875	Dec. 12, 1877	Dec. 12, 1877	Dec. 12, 1877	Jan. 12, 1878
Bavaria .....	Aug. 16, 1878	Aug. 16, 1878	Aug. 16, 1878	Aug. 16, 1878	Aug. 16, 1878
Belgium .....	Nov. 20, 1875	Oct. 31, 1876	Mar. 20, 1877	Oct. 31, 1877	Jan. 12, 1878
Brazil .....	Nov. 17, 1875	do	do	do	do
Buenos Ayres .....	Nov. 21, 1876	Nov. 21, 1876	Dec. 12, 1877	Dec. 12, 1877	do
Canada (Ottawa) .....	Dec. 13, 1875	Oct., 1876	Apr. 28, 1877	Oct. 31, 1877	do
Canada (Toronto) .....	do	do	do	do	do
Chili .....	Dec. 1, 1875	do	Mar. 20, 1877	do	do
Denmark .....	Mar. 20, 1879	Mar. 20, 1879	Mar. 20, 1879	Mar. 20, 1879	Mar. 20, 1879
England .....	Sept. 11, 1876	Oct. 15, 1876	Sept. 22, 1877	Sept. 22, 1877	Jan. 12, 1878
France .....	Nov. 11, 1875	Mar. 20, 1877	Mar. 20, 1877	Oct. 5, 1877	do
Second set .....	July 3, 1879	July 3, 1879	July 3, 1879	July 3, 1879	July 3, 1879
Germany .....	Aug. 7, 1876	Oct. 15, 1876	Mar. 20, 1877	Sept. 12, 1877	Jan. 12, 1878
Greece .....	Oct. 10, 1877	Oct. 10, 1877	Oct. 10, 1877	Oct. 10, 1877	do
Haiti .....	July 24, 1876	Oct. 31, 1877	Oct. 31, 1877	Oct. 31, 1879	do
Holland .....	Dec. 14, 1875	Oct. 15, 1876	do	do	do
Italy .....	Feb. 23, 1881	Feb. 23, 1881	Feb. 23, 1881	Feb. 23, 1881	Feb. 23, 1881
Japan .....	Nov. 9, 1875	Oct. 24, 1876	Oct. 24, 1877	Sept. 13, 1877	Jan. 12, 1878
Mexico .....	Dec. 1, 1875	Oct. 15, 1876	Mar. 20, 1877	Oct. 31, 1877	do
New South Wales .....	July, 1876	Oct. 9, 1876	Nov. 9, 1877	Oct. 17, 1877	do
New Zealand .....	do	do	do	do	do
Norway .....	Dec. 11, 1876	Dec. 11, 1876	Oct. 31, 1877	Oct. 31, 1877	do
Portugal .....	Nov. 11, 1875	Oct. 15, 1876	Mar. 20, 1877	do	do
Prussia .....	Aug. 7, 1876	do	do	Sept. 12, 1877	do
Queensland .....	June 9, 1876	Oct. 9, 1876	Nov. 9, 1877	Oct. 17, 1877	do
Russia .....	Nov. 2, 1881	Nov. 2, 1881	Nov. 2, 1881	Nov. 2, 1881	Nov. 2, 1881
Saxony .....	Aug. 28, 1876	Oct. 15, 1876	Mar. 20, 1877	Sept. 12, 1877	Jan. 12, 1878
Scotland .....	Dec., 1876	Dec. 20, 1876	Sept. 22, 1877	do	do
South Australia .....	July 3, 1876	Oct. 9, 1876	Nov. 9, 1877	Oct. 17, 1877	do
Spain .....	Dec. 9, 1876	Dec. 9, 1876	Nov. 16, 1877	Nov. 16, 1877	do
Sweden .....	Nov. 11, 1875	Dec. 20, 1876	Oct. 31, 1877	Oct. 31, 1877	do
Switzerland .....	Oct., 1876	Oct. 15, 1876	Mar. 20, 1877	Sept. 17, 1877	do
Tasmania .....	July, 1876	Oct. 9, 1876	Nov. 9, 1877	Oct. 17, 1877	do
Turkey .....	Nov. 9, 1875	Nov. 21, 1876	Mar. 20, 1877	Sept. 13, 1877	do
Venezuela .....	July 24, 1876	Oct. 31, 1877	Oct. 31, 1877	Oct. 31, 1877	do
Victoria .....	June 9, 1876	Oct. 9, 1876	Nov. 9, 1877	Oct. 17, 1877	do
Württemberg .....	Jan. 28, 1879	Jan. 28, 1879	Jan. 28, 1879	Jan. 28, 1879	Jan. 28, 1879

*Transmissions of Government exchanges—Continued.*

Country.	Box L (11).	Box M (12).	Box N (13).	Box O (14).	Box P (15).
Argentine Republic .....	Oct. 4, 1878	Oct. 11, 1879	July 30, 1880	Apr. 13, 1881	Oct. 28, 1881
Bavaria .....	Oct. 23, 1878	do	do	Apr. 9, 1881	do
Belgium .....	Oct. 5, 1878	do	do	Apr. 13, 1881	do
Brazil .....	Oct. 23, 1878	do	do	Apr. 9, 1881	do
Buenos Ayres .....	Oct. 4, 1878	do	do	Apr. 13, 1881	do
Canada (Ottawa) .....	Oct. 5, 1878	do	do	Apr. 9, 1881	do
Canada (Toronto) .....	do	do	do	do	do
Chili .....	do	do	do	Apr. 13, 1881	do
Denmark .....	Mar. 20, 1879	do	do	do	do
England .....	Oct. 5, 1878	Feb. 6, 1880	do	Apr. 9, 1881	do
France .....	do	Oct. 11, 1879	do	do	do
Second set .....	July 3, 1879	do	do	Apr. 13, 1881	do
Germany .....	Oct. 23, 1878	do	do	Apr. 9, 1881	do
Greece .....	Oct. 5, 1878	do	do	Apr. 13, 1881	do
Haiti .....	Oct. 4, 1878	do	do	do	do
Holland .....	Oct. 5, 1878	Oct. 13, 1879	do	do	do
Italy .....	Feb. 23, 1881	Feb. 23, 1881	Feb. 23, 1881	Apr. 9, 1881	do
Japan .....	Oct. 5, 1878	Oct. 11, 1879	July 30, 1880	Apr. 13, 1881	do
Mexico .....	Oct. 4, 1878	Oct. 13, 1879	do	do	do
New South Wales .....	do	do	do	do	do
New Zealand .....	do	do	do	do	do
Norway .....	Oct. 5, 1878	do	do	do	do
Portugal .....	do	Sept. 19, 1879	do	do	do
Prussia .....	Oct. 23, 1878	Oct. 13, 1879	do	Apr. 9, 1881	do
Queensland .....	Oct. 4, 1878	do	do	do	do
Russia .....	Nov. 2, 1881	Nov. 2, 1881	Nov. 2, 1881	Nov. 2, 1881	Nov. 2, 1881
Saxony .....	Oct. 23, 1878	Oct. 13, 1879	July 30, 1880	Apr. 9, 1881	Oct. 28, 1881
Scotland .....	Oct. 5, 1878	do	do	do	do
South Australia .....	Oct. 4, 1878	Oct. 13, 1879	Nov. 2, 1881	Apr. 9, 1881	Oct. 28, 1881
Spain .....	Oct. 1, 1878	Sept. 19, 1879	July 30, 1880	do	do
Sweden .....	Oct. 5, 1878	Oct. 13, 1879	do	do	do
Switzerland .....	Oct. 23, 1878	do	do	Apr. 9, 1881	do
Tasmania .....	Oct. 4, 1878	do	do	do	do
Turkey .....	Oct. 23, 1878	do	do	do	do
Venezuela .....	Oct. 1, 1878	do	do	do	do
Victoria .....	Oct. 4, 1878	do	do	Apr. 13, 1881	do
Württemberg .....	Jan. 28, 1879	Oct. 11, 1879	do	Apr. 9, 1881	do

SUPPLEMENTARY NOTICE OF PROCEEDINGS CONSEQUENT UPON THE  
PARIS CONVENTION OF 1875.

The Smithsonian Institution, which has thus for the third of a century undertaken, as one of its fields of activity, a system of free international exchanges of the scientific and literary productions of all countries, has now achieved a magnitude of operations beyond which it finds a further extension impossible with its present limited resources. It has been seen that for the last six years the average cost of its exchange system has slightly exceeded \$10,000 per annum, or one-fourth of its entire income. The growing disposition among various governments, within this period, to support a system of mutual exchange, inspired the hope that our own government would lend its aid in co-operating with so beneficent an enterprise, and in thus establishing our own exchanges upon a truly national basis. With this view various efforts have been made by this Institution; first, to obtain government aid in defraying the expenses incurred in the distribution of government publications; and secondly, to secure the recognition of the really national service of the Smithsonian exchanges generally, and to induce Congress to relieve the Institution of its now over-grown burden; so that its funds might be applied to other pressing demands for "the increase and diffusion of knowledge among men."

An account of the international congress of Paris, and of the concurrence of various governments in its recommendations, is here subjoined, together with the principal portion of the Smithsonian correspondence with the State Department, in relation to the subject of international exchanges.

During the months of August and September, 1875, an international congress of geographical sciences was held at Paris, consisting of several hundred delegates from all parts of the globe, and representing the following national governments: Austria-Hungary, Belgium, Chili, Dominican Republic, France, Germany, Italy, Hungary, Norway, Portugal, Roumania, Russia, Spain, Sweden, Swiss Confederation, Turkey, and the United States of America. A prominent result of this conference was a unanimous resolution to enlist the co-operation of the respective governments there represented in securing the free interchange of official and other publications, in accordance with the following:

PROPOSED PLAN FOR THE INTERNATIONAL EXCHANGE OF SCIENTIFIC PUBLICATIONS  
TO BE SUBMITTED TO THE CONTRACTING POWERS.

The undersigned delegates propose to request their respective governments to organize in each country a central bureau whose duty it shall be to collect such cartographic, geographic, and other publications as may be issued at the expense of the state, and to distribute the same among the various nations which adopt the present programme.

These bureaus, which shall correspond directly with each other, shall

serve to transmit the international scientific communications of learned societies.

They shall serve as the intermediate agents for the procurement, on the best possible terms, of books, maps, instruments, &c., published or manufactured in each country, and desired by any of the contracting countries.

Each country shall transmit at least one copy of its national publications to the other contracting countries.

In order to accomplish this project, the Baron de Vatteville, who was charged by his colleagues with the formation, at Paris, of a central commission of exchanges, convoked a meeting of those signers of the convention of August 12, 1875, who reside at Paris, at the ministry of public instruction.

The commission thus formed, desirous of securing the exchange of publications and official documents relating to the sciences which tend to promote a knowledge of the globe, such as, first, astronomy, geodesy, cartography, geography, topography, geology, mineralogy, botany, anthropology, hygiene, zoology, entomology, explorations and travels, history, archæology, linguistics, numismatics, &c.; and, secondly, statistical information of all kinds, has prepared, discussed, and adopted the regulations mentioned below, which its members will submit to their respective governments for approval.

#### Section I.—*General arrangements.*

*Article 1.* Each high contracting party shall designate in its country a bureau as the center for international exchanges, and shall communicate its exact title and address to the other governments.

*Art. 2.* Each bureau shall prepare a bibliography of the official works published within late years and which they are inclined to exchange. It shall transmit at least one copy of this list to the foreign bureaus, and shall engage to notify these same bureaus of all new official publications as they may appear.

*Art. 3.* The bureau of each country may (subject to the ratification of its government) make use of the opportunity to include in the list of proposed exchanges such publications as are not, strictly speaking, comprised in the category of the sciences above mentioned.

#### Section II.—*Exchanges between governments and departments.*

*Art. 4.* All official documents, that is to say, publications issued at the expense of the state, shall be exchanged gratuitously. With regard to these each high contracting party engages to transmit to the foreign bureaus at least one copy of each of its publications, excepting, however, those which relate to the national defense.

*Art. 5.* If any country shall desire for any purpose to receive more than one copy of the official publications of any other country, the number thereof shall be fixed by a previous arrangement through means of the bureaus of exchange, on the basis of an equitable reciprocity.

#### Section III.—*Exchanges between governments and learned societies.*

*Art. 6.* If any scientific society or institution, whether receiving a subsidy from the state or not, shall desire to receive directly official publications from any foreign country, it shall address the bureau of its

country, which shall serve as agent for obtaining the most favorable conditions.

*Art. 7.* Any modifications of these conditions of the exchanges agreed upon by two countries, relative to the suppression of a document or the transmission of additional copies, must pass through the bureaus of the countries interested.

*Section IV.—Exchanges between learned societies.*

*Art. 8.* The bureau will serve as intermediary between scientific societies, whether subsidized or not, which may desire to make exchanges between themselves, by giving all the information at their disposal. It will also act officially in regard to authors, publishers, or manufacturers of instruments, whose publications or productions may be desired by either a state or a foreign scientific society, in order to procure the advantage of the greatest possible reductions in favor of the applicants.

*Art. 9.* The bureau is not to take any part in the exchanges between clubs or associations which do not have a well-defined scientific or literary character, nor in exchanges between manufacturers, publishers, or authors.

*Section V.—Transmissions and payment of carriage.*

This section remains to be prepared in accordance with the reply which shall be received from the postal union, in reference to the request for free transport which has been addressed to the same on behalf of the commission by the Baron de Vatteville. This is also the case with regard to the protocol, the terms of which can only be determined upon by the different governments in pursuance of a previous arrangement.

Done at Paris, January 29, 1876, council chamber of the ministry of public instruction, &c., division of science and letters, first bureau, under the authority of the minister of public instruction, by the assistant secretary and director of the bureau of sciences and letters.

BARON DE VATTEVILLE,

*President of the Commission for International Exchanges.*

On the 25th of April, 1876, the Hon. Hamilton Fish, Secretary of State, communicated to the Hon. Benjamin H. Bristow, the Secretary of the Treasury, the "proposed plan of international exchange" promulgated by the Paris commission January 25, 1876.

Copies of these communications were transmitted by the honorable Secretary of the Treasury to Professor Henry, the President of the National Academy of Sciences and Secretary of the Smithsonian Institution, with the following letter:

Treasury Department, May 2, 1876.

Prof. JOSEPH HENRY, LL.D.,

*President National Academy of Sciences:*

SIR: I have the honor to transmit herewith for the consideration of the National Academy of Sciences a copy of a letter of the 25th ultimo from the honorable the Secretary of State, inclosing a copy of a communication dated Paris, the 15th of March, 1876, addressed to that department by Dr. W. E. Johnston, in relation to the establishment of a bureau of international exchanges of works of science, together with

copies of a letter of February 23, 1876, from Baron de Vatteville, president of the Commission of International Exchanges at Paris, and a plan adopted by the commission, which it is proposed to submit to the contracting powers.

The department would be pleased to be favored with the views of the Academy of Sciences upon this subject, and any recommendations it may see fit to make.

I have the honor to be, sir, your obedient servant,

B. H. BRISTOW,  
*Secretary.*

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Smithsonian Institution, Washington, D. C., May 4, 1876.

Hon. B. H. BRISTOW,  
*Secretary of Treasury:*

SIR: Your letter of the 2d instant, relative to the establishment of an international bureau for the exchange of works of science, &c., with the accompanying documents, has been received, and in behalf of the National Academy of Sciences, and also of this Institution, I respectfully submit the following as an answer.

From the earliest period of the establishment of scientific societies in America, it has been customary to exchange their publications for those of similar institutions in all parts of the world.

About thirty years ago, as stated by Dr. Johnston, Alex. Vattemare attempted to establish a system of international literary and scientific exchange between France and the United States, and succeeded in interesting in his project several of the States of the Union. The enterprise, however, was an individual one, and fell into disuse principally on account of want of adequate means for carrying it on.

In 1846 the Smithsonian Institution was organized by the bequest of an English gentleman for the "increase and diffusion of knowledge among men." To realize the ideas of the founder it was resolved by the directors of the establishment to institute various scientific investigations, and to send a copy of the published results of these to each of the principal libraries of the world. To carry out this idea it was necessary to appoint paid agents in various parts of the Old World through whom the publications of the Institution might be distributed, and those of foreign institutions received in return. This system was soon afterwards extended so as to include the publications of all the learned societies of the United States, Canada, and South America, with those of the Old World. This has now been successfully carried on for upwards of a quarter of a century, and has been so enlarged as to embrace the institutions of almost every part of the civilized world, as exhibited in the following table.\*

The expense of this system of exchange, which has enriched all the

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\* This table is omitted, as not here important.

principal libraries of the United States and of foreign nations, has been borne entirely by the Smithsonian Institution, and now amounts to nearly seven thousand dollars annually. This expense, however, would be much greater were it not for the generous co-operation of various American, British, French, and German steamship companies, which carry the packages without charge for transportation. As a further extension of the system, Congress has directed that fifty copies of each of its annual publications be given to the Institution for exchange with foreign governments.

In view of the foregoing statements, I do not think it in the least degree probable that the Government of the United States would think it advisable at present to establish a special bureau for co-operating in the plan proposed by the congress of geographical sciences.

I may say, however, in behalf of the Smithsonian Institution, that it will cheerfully co-operate with the system proposed as soon as it has succeeded in establishing its organization, and also that if, at any time, the Government of the United States chooses to assume the expense of a purely national establishment, the Institution would devote the money it now expends in this direction to other objects connected with the "increase and diffusion of knowledge among men."

I have the honor to be, yours, respectfully,

JOSEPH HENRY,

*President National Academy and Secretary Smithsonian Institution.*

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[The Portuguese commissioners to the president of the Belgian commission.]

Lisbon, March 1, 1877.

SIR: The agreement signed August 12, 1875, by yourself and the Portuguese commissioners on the occasion of the geographical congress at Paris, is without doubt the most valuable result of that scientific and truly international reunion which has contributed in so efficacious a manner in drawing closer the intellectual relations already established between the nations they represented.

The scientific literary and art exchanges organized, in a sure and permanent manner, in aiding unquestionably in the rapid and thorough diffusion of science, ought to create indissoluble bonds of union between the different groups of the human family—bonds which cannot fail to be most profitable to the great cause of civilization.

True to its agreement, and convinced of the immense advantages which must spring up for all nations from the realization of so generous a thought, the Portuguese Government has appointed a commission provisionally charged with the organization of the service of scientific, literary, and art exchanges on such a basis which should not sensibly deviate from that which we have the honor to communicate to you herewith, and which has been accepted by the commissioners residing at Paris, who constitute an international committee.

Our commission, however, composed of the undersigned, and provided with the necessary power by a decree of the ministry of foreign affairs, and of which inclosed you will find the translation, held that it should first address itself to the signers of the agreement of August 12, for the purpose of informing them of its organization and of requesting them to furnish the necessary information which it needs for a proper discharge of the duties with which it is intrusted.

It is with a view to the accomplishment of this, for us so honorable, mission, that we beg you, sir, to communicate to us the ideas and resolutions of your government on this point; also, what steps should be taken to establish promptly and surely the service of scientific, literary, and art exchanges between Portugal and Belgium, on a permanent, official, and as extensive a basis as possible.

It is also our duty to inform you that the Portuguese Government has instructed its representatives abroad to communicate to the governments to which they are accredited the establishment of our commission of international exchanges, and also the names of the members of which it is composed.

Accept, sir, the assurance of our most distinguished consideration.

MARQUIS DE SOUZA HOLSTEIN.

JOSÉ JULIO RODRIGUEZ.

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[Circular of the Belgian commission to the learned societies of Belgium.]

We have had the honor of explaining to you in a former circular, which was addressed to you in 1873, that by royal decree of May 17, 1871, a commission was appointed charged with the organization of a system of exchange between Belgium and foreign countries, of either writings in every branch of intellectual activity or reproductions of the principal monuments, or the most valuable objects in connection with the graphic or plastic arts. The commission has been divided in three sections; the second, representing the interests of literature, bibliography, and numismatics, has inaugurated its labors by the publication of a catalogue in which is contained a statement of all periodic publications issued in Belgium by learned societies, the departments, associations, and private individuals. In the preparation of this list our section made use of the documents transmitted by you in answer to the above-named circular. This list appeared in the course of the year 1874 under the title of "Introduction to the bibliography of Belgium: Brussels. Henry Manceaux." At the instance of our section the government has also accorded its patronage to the same publisher for a bibliography of Belgium. After having taken other steps with a view to the completion of its organization, our section has now finally been placed in the position of commencing active operations. We have been able, consequently, upon the agreement signed by the delegates of



twenty-two nations at the geographical congress at Paris in 1875, to enter into relations with several committees already established abroad.

The time has arrived for us to ask you that you will indicate precisely what you are able to place at our disposal from among the publications issued by your society since its foundation, be it from the stock on hand or from future continuations of series, informing us of the number of copies still at your disposal, as also their price.

It is understood that the publications now issuing as well as the following numbers are to be furnished at the subscription price. In regard to those of previous years we trust that, in consideration of the fact that it would increase the number of subscribers for your publications, you will settle upon a moderate price, so that we may be able to accept of it.

At some future time when we shall have received from foreign countries catalogues of works we may procure from them we shall have the honor of communicating it to you so that you may indicate which of the works would be desirable for you. In the majority of cases we shall make return in kind of what you have furnished us; but the amount for those you will have asked of us and we furnished will be deducted and your account will be settled every year.

What we expect of your courtesy at present is the indication of the material for exchange which we may procure from your society.

Accept, &c., &c.

L. ALVIN, *President*:

CHAS. RUELENS, *Secretary*.

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[The Smithsonian Institution to the State Department.]

Smithsonian Institution, June 3, 1878.

Hon. WM. M. EVARTS,

*Secretary of State*:

SIR: I have the honor to acknowledge the receipt of your letter of May 15, inclosing a communication from W. E. Johnston, M. D., in reference to the subject of international exchanges between the United States and France.

In reply I beg to inform you that this Institution has been for a number of years charged by Congress with the duties of exchanging its official publications and those of the various departments of the United States Government for similar publications of foreign governments, France among the number.

This Institution has also for a still longer period maintained a much more comprehensive and extended system of communication between learned societies and specialists of the New World and those of the Old, receiving serial and other publications from South and Central America, the West Indies, and the British provinces of North America, as well as those of the United States, and transmitting them through its agents abroad. These, in turn, receiving any parcels from the countries

represented by them for transmission to any portion of America, likewise through the Smithsonian Institution.

A special element in the Smithsonian system of international exchanges consists in the employment of a number of agents in different portions of Europe, a list of whom is herewith inclosed. It will be seen that the agent of France is Mr. Gustav Bossange, the well-known bookseller, of Paris.

It will be entirely agreeable to the Smithsonian Institution to adopt any plan of communication between the United States and France that may be considered an improvement upon the present, although it could not now undertake to assume any responsibility beyond that of taking charge of official publications interchanged between the two governments, and of any parcels addressed to scientific individuals and institutions.

If the Department of State should think proper to instruct the American minister at Paris to serve as agent in these transactions it will be an improvement upon the present system which we shall be happy to see carried into effect.

I am, very respectfully and truly, your obedient servant,  
 SPENCER F. BAIRD,  
*Secretary of Smithsonian Institution.*

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[The State Department to the Smithsonian Institution.]

Department of State, Washington, August 28, 1878.

SPENCER F. BAIRD, Esq.,

*Secretary of the Smithsonian Institution, Washington, D. C.:*

SIR: Referring to your letter of the 3rd of June last to this department in relation to the international exchange of works of science, a copy of which was transmitted to our minister at Paris, and by him communicated to Dr. Johnston, the American delegate to the congress for promoting the organization of a more extensive system of such exchanges, I have the honor to inclose herewith, for your consideration, a partial report just received by this department from Dr. Johnston as to the proceedings of the congress in relation to the subject-matter of this correspondence.

I am, sir, your obedient servant,  
 F. W. SEWARD,  
*Acting Secretary.*

[Inclosure.]

Paris, August 5, 1878.

His Excellency WM. M. EVARTS,

*Secretary of State:*

SIR: In reply to your excellency's letter of June 10, addressed to the American minister at Paris, and that of Mr. Baird, Secretary of the Smithsonian Institution, of June 3, accompanying, both relating to the proposed official organization of a system of international exchanges of

works of science, I have the honor, at the request of Mr. Hitt, chargé d'affaires, to again address you on the subject, and to lay before you some other considerations in regard to this scheme.

All the governments which are represented by diplomatic agents at Paris, with the exception of England and Germany, which still hold out in order to first see the working of the scheme, have given in their adhesion and agreed to the creation, within the bureaus of their respective foreign secretaries, of an agency, with a special employé, charged with the duty of international exchanges of works of science.

It is hoped that an arrangement may be made in regard to the transportation of these exchanges which will reduce the expenses to a mere trifle.

Will the Smithsonian Institution, which is already organized for this kind of work, and which has been making exchanges with a certain number of foreign governments for a good many years, assume to do this work, on the more enlarged and more official scale which is now proposed, and enter, as the occasion presents, into direct communication with the different foreign bureaus; or will it demand to do this work through the foreign legations of the United States; or, finally, will it prefer, if the State Department will do this work, to abandon it to the State Department entirely?

The foreign bureaus would much prefer, for the sake of simplicity and uniformity in the service, that the work should be done in the United States exactly as it is done here—that is to say, by a special bureau established within the State Department. The American legation at Paris would also prefer that the exchange should be made by direct communication through the bureau, rather than through its agency, and it is probable that the other European legations, where exchanges are to be made, would also prefer the direct communication.

Nevertheless, as regards the Smithsonian Institution, the relations of this Institution to the government, and its superior facilities for this kind of work, are so well known that in the various meetings of the congress no objection was ever raised to its assimilation with the purposed official bureaus of the different governments.

As I have already had the honor of informing your excellency, the last meeting of the congress was composed, exclusively, with the exception of myself, of official personages, some thirty in number, mostly members of the diplomatic corps; and I desire to know of your excellency whether it would not be more appropriate for one of the members of the American legation to assume hereafter the duty of representing the United States in this congress. In view of the fact, however, that there may not be more than one or two more meetings of the congress, I have been requested by the legation to continue to fill the duty of the delegate to the end.

I have the honor to be, very respectfully, your obedient servant,  
W. E. JOHNSTON, M. D.

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[The Smithsonian Institution to the State Department.]

Smithsonian Institution, September 17, 1878.

Hon. WM. M. EVARTS,  
*Secretary of State :*

SIR: I have the honor to acknowledge the receipt of a communication from the State Department, dated August 28, inclosing a letter

from Dr. W. E. Johnston, of the 5th of August, in reference to the participation of the Smithsonian Institution in the system of international exchanges.

In reply to the suggestions of the letter referred to, I beg leave to say that the Smithsonian Institution has been engaged for nearly thirty years in the development of its present system of international exchanges, prosecuted almost entirely at the expense of the Smithsonian fund; that it has thoroughly met the needs and wishes of the scientific men of both countries, and that unless there is some assurance that the work can be carried on with equal efficiency under some new arrangement it would be considered inexpedient by the Board of Regents to make any change. If, however, the Government of the United States will undertake the entire expense of the work and its management on a scale that will meet all the requirements, it is very probable that the assent of the Board of Regents can be had to the proposition to transfer it to a new organization, and thus be enabled to devote funds thus released in some other direction.

This, of course, according to the letter of Dr. Johnston, would involve the assumption of the labor at least by the State Department, and the securing of the necessary appropriations from Congress for the purpose.

If I am informed by the State Department of its readiness to undertake the expense and responsibility attendant upon the assumption of the system of international exchanges in question, I will take pleasure in referring the matter to the Board of Regents for its action.

Very respectfully, your obedient servant,

SPENCER F. BAIRD,

*Secretary of Smithsonian Institution.*

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[The State Department to the Smithsonian Institution.]

Department of State, Washington, September 26, 1878.

Prof. SPENCER F. BAIRD,

*Secretary of the Smithsonian Institution:*

SIR: I have received and carefully considered your letter of the 17th instant, in reply to the letter of this Department of August 28th ultimo, in relation to the international system of exchanges of scientific publications proposed by a conference at Paris, in which the United States is represented by Dr. W. E. Johnston.

I quite agree with the opinion expressed through you by the Board of Regents, that it is inexpedient to make any present change in the admirable and efficient system of literary exchanges with foreign countries inaugurated by the Smithsonian Institution nearly thirty years ago, and since then developed to its present proportions.

The letter of Dr. Johnston, of August 5, of which a copy was sent to you with the Department's letter of 28th ultimo, states that "the rela-

tions of the Smithsonian Institution to this government, and its superior facilities for conducting exchanges of the kind proposed, are so well known, that, in the various meetings of the congress, no objection has been raised to its assimilation with the proposed official bureaus of the different governments." It is believed that there is no obstacle to effecting such an assimilation substantially on the basis of the suggestions contained in your letter of June 3, 1878.

The United States minister at Paris has therefore been directed to convey, through Dr. Johnston, to the international conference the opinion of this government, that, so far as its special domestic bureau of exchange is concerned, it is preferable to leave the work with the Smithsonian Institution rather than to replace it by the organization of a new bureau *ad hoc* in the Department of State, but that no objection is seen to entering into a common arrangement of international exchange, provided that the operations of the Institution be assimilated with those of the foreign bureaus so as to enable it to act as though it were, for the special purpose in view, a bureau of the foreign department of this government.

As you make no categorical answer to the inquiry contained in Dr. Johnston's letter of the 5th ultimo, as to whether the Smithsonian Institution will consent "to assume to do this work on the more enlarged and more official scale which is now proposed, and enter, as the occasion presents, into direct communication with the different foreign bureaus, or will it demand to do this work through the foreign legations of the United States," it is inferred that any practical arrangement sanctioned by the conference will meet the approval of the Board of Regents. Mr. Noyes will, therefore, be instructed to advise Dr. Johnston in that sense, and leave the details of assimilation to the deliberation of the conference, inclining, however, if there be no impediment to such a course, to favor the designation of the legations of the United States in foreign countries as the channels of communication between the several foreign bureaus and the Institution, as apparently contemplated in your letter of the 3d of June last. Any special consideration which you may be disposed to advance on this point will nevertheless receive prompt attention.

I am, sir, your obedient servant,  
WM. M. EVARTS.

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[The State Department to the Smithsonian Institution.]

Department of State, Washington, October 30, 1878.

Prof. SPENCER F. BAIRD,

*Secretary of the Smithsonian Institution :*

SIR: I transmit to you herewith a copy of a note received from the minister of Portugal in this country, giving information of the action of the Portuguese Government with reference to exchanges of publications

with foreign governments. The department will communicate to the minister the substance of any statement which may be received from you in relation to the subject.

I am, sir, your obedient servant,

F. W. SEWARD,  
*Assistant Secretary.*

[*Inclosure No. 1.—Translation.*]

*Note from Viscount Das Nogueiras.*

Legation of Portugal,  
Washington, 19th of October, 1878.

MR. MINISTER: I have the honor to inform you that for the purpose of organizing, upon the basis of the geographical congress of Paris in 1875, the service of scientific, literary, and artistic exchanges between Portugal and the foreign nations, and to the end of profiting by the offers already made by different countries of commencing to send to Lisbon several collections of inestimable value, the government of His Most Faithful Majesty has named, in order to provisionally constitute a Portuguese committee of exchanges, the Marquis of Souza Holstein, peer of the kingdom, vice inspector of the Royal Academy of Fine Arts, member of the Royal Academy of Sciences, member of the central permanent committee of geography, and José Julio Rodrigues, professor to the polytechnic school, chief of the photographic section of the general direction of geodetic works, member of the Royal Academy of Sciences, secretary of the permanent central committee of geography.

In making the communication to you, I hope, Mr. Minister, that the persons composing the Portuguese committee will be officially recognized in their relations with the committees of the United States.

I profit by this occasion to renew to you the assurance of my high consideration,

VISCOUNT DAS NOGUEIRAS.

[*Inclosure No. 2.—Translation.*]

*Declaration of the Portuguese Government relative to the establishment of a provisional commission of international exchanges.*

Ministry of Foreign Affairs, November 21, 1876.

In consideration that it is of the greatest importance to organize without delay the service of scientific, literary, and art exchanges between Portugal and foreign countries, although it be only provisionally and until such definite action may be taken as the importance of the subject demands, in conformity with the basis laid down at Paris at the congress of 1875, and in accordance with the negotiations entered upon ;

In consideration that it is important not to delay the work commenced

by His Majesty's Government for the purpose of securing for the Portuguese public establishments numerous and valuable elements for study ;

In consideration that it becomes indispensable to profit by the offers made by several foreign countries which desire to send to Portugal collections of incontestible value:

His Majesty the King decrees, through the ministry of foreign affairs, that the Marquis of Souza Holstein, senator, &c., &c., and José Julio Rodrigues, professor at the polytechnic school of Lisbon, &c., &c., be provisionally charged with the organization of the above-named service of scientific, literary, and art exchanges between Portugal and foreign countries, authorizing them to make requisition to the above ministry for what they may need for the perfect accomplishment of the mission which His Majesty has deigned to confide to their zeal and patriotism.

Given at the Palace October 28, 1876.

JAAO D'ANDRATE CORVO.

Countersigned.

*Minister of Foreign Affairs,*

JORGE CESAR DE FIGANIERE.

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[The Smithsonian Institution to the State Department.]

Smithsonian Institution, November 7, 1878.

HON. WILLIAM M. EVARTS,

*Secretary of State :*

SIR: In acknowledging the receipt of your communication of September 26, concerning the system of international exchanges to be conducted under government auspices by the various nations of the world, I beg to renew the assurance that the Smithsonian Institution will be pleased to enter into any relations of the kind in question that may be authorized by its Board of Regents. The precise form of co-operation on the part of the Institution will probably be deemed by the board as immaterial, provided the result is likely to add to the renown of Mr. Smithson, the founder of the establishment.

Whether the parcels that may be on hand for the rest of the world shall be delivered to the foreign legations here, or forwarded through the American legations abroad, is a matter of no special moment. Whatever practicable system may be adopted by the international convention will be duly considered and doubtless adopted by the board.

I have also the honor to acknowledge the receipt of a letter of October 30, inclosing a communication from the legation of Portugal, designating a commission in Lisbon to receive and take charge of any future transmissions to that country from the United States.

Very respectfully, your obedient servant,

SPENCER F. BAIRD,

*Secretary of Smithsonian Institution.*

[The State Department to the Smithsonian Institution.]

Department of State, Washington, November 14, 1878.

Prof. SPENCER F. BAIRD,

*Secretary of the Smithsonian Institution:*

SIR: Your letter of the 7th instant, in relation to the contemplated assimilation of the Smithsonian Institution's system of international exchanges with the international bureau which it is proposed to establish in accordance with the conclusions of the Paris congress, has been received.

It is a source of gratification to this government to learn the readiness of the Smithsonian Institution to enter into any practicable arrangement which may be made in furtherance of an extended international scheme of exchanges.

The details, however, of the proposed arrangement, so far as the other countries are concerned, are but imperfectly known at present, although it is believed that the plan is such that the Smithsonian Institution, in merging its exchange system therein, would not only increase its sphere of operations, but be relieved to a great extent of the trouble and expense involved in transmitting foreign exchanges to this country. At any rate, knowing the great benefits which have accrued and are accruing to scientific effort in all parts of the world through the well-ordered exertions of the Smithsonian, this department would not favor any arrangement which might tend to curtail in any way the comprehensive results now attained.

An instruction has been to-day sent to the United States minister at Paris, requesting him to obtain, if possible, precise information as to the working details of the proposed international arrangement, in order that the question whether the Smithsonian plan of exchanges can be thereto assimilated may be understandingly considered. Mr. Noyes has been especially directed to ascertain what facilities of exchange, if any, it is proposed to accord to private scientific organizations and individuals, whether in the countries adhering to the proposed plan or in countries outside of its scope. If a practicable basis can be found for the assimilation of the operations of the Smithsonian bureau of exchanges with those of the international bureau, it is conceived that it should secure to the former full freedom of action for so much of its present plan of work as may not be embodied in the contemplated scheme.

I am, sir, your obedient servant,  
WM. M. EVARTS.



[The State Department to the Smithsonian Institution.]

Department of State, Washington, January 10, 1879.

Prof. SPENCER F. BAIRD,

*Secretary Smithsonian Institution :*

SIR: Referring to my letter of the 14th of November last, addressed to you, in relation to the contemplated *assimilation* of the Smithsonian system of international exchanges with the plan proposed by the international congress at Paris, I have now the pleasure to transmit herewith copy of a recent dispatch from the United States minister at Paris, inclosing a communication from Dr. William E. Johnston in answer to the specific inquiries of the department.

It appears from Dr. Johnston's report that no essential change has been made in the plan proposed two years ago for the organization of the international bureau and the conduct of the business of reciprocal exchange. The "printed documents" referred to were received with a letter from Dr. Johnston, dated March 15, 1876, and, being sent to the Secretary of the Treasury, were, by that officer, referred to your predecessor, Dr. Henry, whose reply, under date of May 4, 1876, has formed the basis of the subsequent proceedings and instructions of this department in the matter. For your convenience, however, I transmit herewith the duplicate copy of the "projet de reglement" received from Dr. Johnston.

You are already aware of the desire of this department to secure to the Smithsonian Institution, in event of its admission to the proposed international system, the fullest liberty of action and the utmost enhancement of its utility, without entailing any additional burden on its resources. It is thought that this can be accomplished without difficulty.

To that end, I will, however, thank you to make a careful review of the whole subject, in the light of Dr. Johnston's last report, with a view to determine the precise status of the Smithsonian as an international bureau under the projected plan. I would suggest that a detailed memorandum setting set forth the bases on which your co-operation could be effected, on the plan of the circular of the ministry of public instruction and the fine arts which accompanied Dr. Johnston's letter of March 15, 1876, would be very serviceable for submission to the Paris congress.

I am, sir, your obedient servant,  
WM. M. EVARTS.

[Inclosure No. 1.]

Legation of the United States, Paris, December 13, 1878.

Hon. WM. M. EVARTS,

*Secretary of State :*

SIR: Referring to your dispatch No. 107, of November 14, 1878, I have the honor to inclose herewith a copy of a communication from Dr. William E. Johnston (with two documents annexed), which discusses and

answers so fully the questions contained in your dispatch that I will only add that I approve the remarks and conclusions of the writer.

I have the honor to be, your obedient servant,

EDWARD F. NOYES.

[Inclosure No. 2.]

Paris, December 9, 1878.

His Excellency General NOYES,

*Minister of the United States, Paris :*

DEAR SIR: In reply to your demand for information in regard to the proceedings of the conference for organizing a system of international exchanges of works of science, I have the honor to send you herewith inclosed two copies of the plan drawn up by the conference, and one copy, the only one in my possession for the moment, of the plan of organization of the French bureau for carrying out the French part of the scheme.

I beg leave, however, to recall through you, to the memory of the State Department, that I have already nearly two years ago furnished copies of these documents to that department.

I take this occasion to state that no alterations or amendments were made in the subsequent meetings of the conference to the printed documents herein sent. They will be found to cover most of the questions which you desired answered.

But in reply to the question of the honorable Secretary of State as to how the exchanges are to be made, I would state that in the discussions of the conference it was assumed as a matter of course that they should be made directly from bureau to bureau without passing through the respective legations, and that in all probability the postal service could be obtained gratis.

These points had not been otherwise determined at the last meeting, and I am not able to state at this moment whether any arrangement has yet been made about free transportation or not. This question will undoubtedly come under consideration at the next meeting of the conference, and I will take the earliest occasion thereafter to inform you of the proceedings of the conference on the subject.

The great exhibition of this year, and the unusual activity in local and national affairs of the new minister of public instruction and fine arts (at whose office and under whose auspices the conference was held), have prevented any meeting of the conference for nearly a year. It will not, however, be long before another meeting is called.

If the honorable Secretary of State of the United States, or the honorable director of the Smithsonian Institution, which has so large an experience in the matter of international exchanges, desire to introduce any modifications into the printed plan herewith sent, or add any new features thereto, I will only be too happy to propose these modifications or amendments at the next meeting of the conference, and can guarantee in advance a favorable hearing.

I may add finally that at the last sitting of the conference the only governments which hesitated to give in their adhesion were those of England and Germany. The delegates of these governments demanded time to see the operation of the scheme, but it is expected that they will finally adhere.

I have the honor to be, with the highest sentiments of esteem, your most obedient servant,

WM. E. JOHNSTON, M. D.,  
*Delegate for the United States.*

[The Belgian Commission to the Smithsonian Institution.]

Brussels, January 24, 1879.

DIRECTORS OF THE SMITHSONIAN INSTITUTION:

GENTLEMEN: On the 25th of May, 1878, we had the honor to forward to you a considerable number of Belgian publications in exchange for those which you had sent to us some time previously.

We hoped by this sending to establish a system of regular transmissions of our respective intellectual productions between your Institution and our exchange commission.

We sent you at the same time the papers relative to the organization of our exchange system, a list of our periodical publications, and the Bibliography of Belgium, begging you to indicate what works you desired. Finally, we informed you of our own desiderata.

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We therefore earnestly entreat you, gentlemen, to consider the matters treated of in our note. An agreement upon a regular system of exchange would be of great advantage to science and to the progress of which your Institution is a powerful promoter.

Accept the assurance of my highest consideration.

L. ALVIN, *President.*

C. RUELENS, *Secretary.*

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[The Smithsonian Institution to the State Department.]

Smithsonian Institution, February 5, 1879.

HON. WILLIAM M. EVARTS,

*Secretary of State:*

SIR: I have the honor to acknowledge the receipt of your letter of the 10th of January in reference to the participation, by the Smithsonian Institution and the State Department, in the proposed system of international exchanges, suggested and in a measure established by the international congress of Paris, together with inclosures from the American minister at Paris, and a memorandum of proposed regulations and conditions.

Apologizing for the necessary delay in my reply, I beg to say that the direct exchange between the Smithsonian Institution and the French bureau has commenced by the receipt of one box of scientific publications from Paris, and the transmission of several boxes by the Smithsonian Institution.

The schedules of the contents of the one box already received, and of another not yet to hand, have been forwarded by the Baron de Vatteville, who is in charge of the Paris agency; and it is probable that the work will be continued now without any serious impediment.

The Smithsonian Institution is now making up a large sending for Paris, which will fill fifteen or twenty boxes, and be transmitted in ac-

cordance with the proposed plan. This, as I understand it, is to be as follows: The Smithsonian Institution, in continuation of its arrangement with the Library of Congress, will forward at least once a year to the agency in Paris a complete set of the publications of the United States Government, provisions having been made to that end by law of Congress directing the Public Printer to reserve fifty sets for international exchange of all works printed by the government office, whether by direct order of Congress or by the departments. This, of course, does not include any confidential papers for the State or other departments, but does embrace their general circulars, reports, &c., prepared for their own use.

Secondly, the Smithsonian Institution will receive from the various societies of the United States publishing transactions, and from men interested in research, and maintaining relations with correspondents abroad, whatever they may wish to forward to France. All the parcels for any one address will be concentrated in one or more bundles, each bearing the address of the proper party, and indorsed as sent by the Smithsonian Institution. The parcels will then be inclosed in the necessary number of boxes and addressed to the bureau of the French agency, and forwarded from New York by suitable vessel; steamer, if the amount is small; sailing-vessel, if large. A bill of lading will, of course, be sent to the agency, together with a detailed invoice of the several addresses.

The Smithsonian Institution will deliver its boxes at the seaport free of charge; after that, the expense of transmission to Paris will be borne by the French bureau.

In return, it is expected that the French bureau will, in the first place, charge itself with the gathering together and transmission of all the public documents of France, and that it will receive all parcels delivered to it by societies, institutions, and individuals in France for transmission to correspondents in America.

It is to be understood that, as heretofore, the Smithsonian Institution will include in its transmissions all the publications of the various departments of the United States Government and those of American countries outside of the United States, such as Canada, Mexico, Chili, &c. It will also be willing to receive from the Paris agency corresponding parcels for Canada and other portions of America.

I beg to inclose also certain rules which have lately been put in force by the Smithsonian Institution in connection with its system of international exchanges, in which certain restrictions are indicated, which may properly be followed by the French bureau. The principal of these consists in the refusal to receive any parcels that are in any way dutiable, such as books purchased for the use of private individuals, as well as scientific and philosophical apparatus, &c. It is also proposed to place a restriction upon the transmission of objects of natural history which are extremely bulky, and the interchange of which is in most

cases a matter of pecuniary profit and not for the advancement of science. Special exceptions will always be made in regard to applications for the transmission of articles of the kind sent to any of the leading public museums of the country.

It will, of course, be understood by the Department, as previously explained, that the exchange of government publications is directly in the interest of the Library of Congress, and that all the works received by the Smithsonian Institution itself are placed on deposit in the same establishment.

If, as suggested by the American minister to France, it becomes possible to send packages of international exchanges free by post, it will greatly relieve the labor and responsibility of the work, permitting the sendings to be made with much greater frequency.

I have the honor to be, very respectfully, your obedient servant,

SPENCER F. BAIRD,

*Secretary of the Smithsonian Institution.*

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[The Smithsonian Institution to the French Commission.]

Smithsonian Institution,

Washington City, February 8, 1879.

Baron R. DE VATTEVILLE,

*Commissiioner des Échanges Internationaux, Paris, France:*

DEAR SIR: In addressing you in regard to the subject of the international exchange between the Smithsonian Institution and the bureau under your direction, I write at much length, even at the risk of repeating the substance of previous letters, being desirous of making complete and satisfactory arrangements for the future prosecution of this important work.

As you are doubtless aware, the Smithsonian Institution has for many years been engaged in the development of a system of international exchange, which is now very extensive and complete, and so far has been conducted entirely at its expense, and not by appropriations of the United States Government. The actual outlay amounts to more than \$10,000 a year, or to more than one-fourth of the entire Smithsonian income.

This exchange consists of two divisions:

The one embracing exclusively the publications of the United States Government, to be exchanged for corresponding publications of other governments.

The other consisting of the works of the various learned and scientific societies and of scientific men.

The system of government exchanges was initiated by the Smithsonian Institution in 1867, at which time the inclosed circular was issued by my predecessor. It was intended to embrace everything printed at the expense of the United States Government, with the guarantee that

nothing whatever should be omitted, however trivial and apparently unimportant. These publications were to be sent to such governments only as would agree to make an equally exhaustive return, the transmissions to be made respectively at times most convenient to the contracting parties, on the part of the United States about once a year.

The Smithsonian Institution agreed to deliver its boxes, free of expense, at New York, or any other convenient point of shipment in the United States, the remaining charges to be met by the recipient. The returns in like manner to be delivered at a seaport in Europe; the remaining expenses to be paid here.

Various delays occurred, and it was not until 1873 that the first transmission could be made.

At present thirty-two sets of forty-eight, reserved for the purpose, are disposed of to as many governments; sixteen sets remaining on hand, each occupying eleven boxes, of about 300 pounds. As France has received the first eleven boxes of the series, the continuation will consist of the twelfth and succeeding numbers.

What we especially desire now from France in return for this sending is not merely the special publications of some of the scientific bureaus, but a series of everything published by the state, as complete as that which we send, to include the records of the legislation of the republic, its reports upon education, statistics, commerce, navigation, topographical and geological explorations, &c.

Can we look forward to this through your instrumentality? We do not expect that the series can commence as far back as that which we have sent, and are quite willing to have it begin with the present year, or perhaps with 1878.

Will it not be expedient to secure in France some provision like that made by the United States Government, and which alone will accomplish the desired object, namely, that of directing the Public Printer to reserve a certain number of copies of every official document for the purpose of international exchange?

The second division of our system of exchanges is that relating particularly to learned societies and men of science; it also includes transmissions of separate bureaus of the United States Government to their correspondents. The publications of the latter class are all embraced in the full series of the governmental exchanges included in the first division and are consequently duplicates, very useful, however, for bureaus, public libraries, scientific societies, &c.

I beg to inclose the rules lately adopted for the guidance of correspondents of the Smithsonian Institution. These, you will see, exclude objects of natural history except when especially authorized. There is at present an immense amount of interchange of plants, minerals, and other objects of natural history between amateurs, which is of no special advantage to science. We therefore propose to exclude natural history objects, excepting in the interest of some special scientific research.

It is to be noted in this connection that the Smithsonian Institution discharges its function of intermediary of exchange, not merely between the institutions of the United States, but also of all America; and that it is the established agent of exchange for the societies of Canada, as well as of Mexico, of Chili, and other Central and South American States. This policy it is entirely willing to continue, and you can, therefore, without hesitation, send any parcel that may come to your agency addressed to any portion of America, the further transmission and final delivery of which we promise within such time as may be practicable.

I now beg leave to make some suggestions for the more thorough accomplishment of the object which we both have so much at heart.

In the first place, I would ask that all boxes be addressed "Smithsonian Institution, Washington, care of the Collector of Customs, New York," and that two regular bills of lading of the shipment from Havre or other seaport of France to New York be sent to the Smithsonian Institution simultaneously with or before the transmission. In this way we shall have no difficulty in looking after the box or boxes and in securing their arrival in Washington at the earliest possible moment.

Of course, if you have an agency in New York, we shall be pleased to be placed in communication with it. But such agency is not necessary if you will send duplicate bills of shipment, as suggested.

If it is more convenient to you to have all the charges from Paris to Washington paid here, and in the same way to receive the boxes from Washington and pay the expenses in Paris, it will be equally agreeable to us.

May we not assume—which I trust is the case—that your bureau will receive, without any restriction whatever, everything sent by the Smithsonian Institution intended for public bureaus, learned societies, libraries, and men of the whole of France and its dependencies in Algeria, and that it will see to the further transmission of these packages from Paris?

Should this trust be accepted, we will notify the consignee of each sending that a package has been forwarded through you, and instruct him or it to apply to you for the same.

Of course, we accept an equally exhaustive mission on our part. If authorized, we will send a circular to each of our correspondents in France, instructing them to send all parcels to you instead of to M. Bossange, our present agent, who has recently failed in business.

I greatly regret to state that the collection of books advised by you under date of July 22 has not yet come into our possession. I have written to M. Bossange, asking him for information on the subject. Is it certain that it was sent to that agent?

The invoice of the 27th of September has been duly received, but all the works enumerated were not found. I beg to send herewith a list of what is still wanting.

If I understand aright, the rules of the international bureau contemplate the placing of packages intended for a particular country in the

hands of the resident minister of that country; or, in other words, that the parcels from the Smithsonian Institution for your country are to be turned over to the minister of France in Washington, and those for the United States to the American minister in Paris.

It is quite immaterial to us which method is preferred, although, as a matter of business, we think the transmission can be made more direct by ourselves to New York, and by you to Havre. Please advise us on this head.

Trusting that the length of this communication will be justified by the desire to put on a proper basis so important a transaction as that of the international exchange of the whole of America with the Republic of France,

I have the honor to be, very respectfully, your obedient servant,  
 SPENCER F. BAIRD,  
*Secretary of Smithsonian Institution.*

[The State Department to the Smithsonian Institution.]

Department of State, Washington, February 8, 1879.

Professor SPENCER F. BAIRD,

*Secretary of the Smithsonian Institution:*

SIR: I inclose herewith for your information a copy of a letter addressed to this department by the principal librarian of the British Museum, conveying the thanks of its trustees for the present in continuation of former donations of certain public documents of the Government of the United States, which were received through the Smithsonian Institution.

I am, sir, your obedient servant,  
 F. W. SEWARD,  
*Assistant Secretary.*

[Inclosure.]

British Museum, January 25, 1879.

The SECRETARY OF STATE,

*Government of the United States:*

SIR: I am directed by the trustees of the British Museum to acknowledge the receipt through the Smithsonian Institution of the present which the Government of the United States has been so good as to make to them, in continuation of former donations, of the series of the reports of the committees of the United States Senate, 1877-'78, Washington, 1878, 8vo., together with a collection of reports and other State papers, referring to the administration of the Government in the United States, during the years 1877-'78.

I am requested that you will be pleased to cause the expression of the best thanks of the trustees of the British Museum to be conveyed to the Government of the United States for this present, which constitutes an addition of much interest to the national library of this country.

I have the honor to be, sir, your most obedient, humble servant,  
 EDWARD A. BOND,  
*Principal Librarian.*



[The Smithsonian Institution to the Belgian Commission.]

Smithsonian Institution,  
Washington City, March 13, 1879.

Monsieur L. ALVIN,

*President of Belgian Commission of  
International Exchanges, Brussels, Belgium:*

SIR: I have to apologize for the temporary cessation of the correspondence between yourself and the Smithsonian Institution in reference to the proposed system of international exchange.

The death, in May last, of my lamented predecessor, Professor Joseph Henry, has caused an interruption in the business of the Institution, from which it has only recently recovered; but I trust that the matters referred to will hereafter be prosecuted with due dispatch and accuracy.

The Smithsonian Institution, as already explained to your honorable commission, has now in charge two distinct departments of international exchanges. The first is that carried on in behalf of the Government of the United States for the benefit of the national library at Washington. For this purpose the official printer is instructed to reserve fifty sets of the publications, not only of the Congress of the United States, but also of the several bureaus of the government, and to send forty-eight of these to the Smithsonian Institution, the other two being delivered to the national library. One complete series is sent to each government agreeing to make an equally complete and exhaustive return. Under this arrangement there is absolutely no print issued, however small and insignificant, or however costly to the government, that is not included in the series; and a like return is expected, even though the aggregate amount be very much less.

The second division is that prosecuted in behalf of learned societies, the various bureaus of the government, and the scientific and literary men of America. This embraces all publications of learned societies, scientific periodicals, monographs, and other works, but does not include specimens of natural history or of the fine arts, unless permission is especially obtained. An accompanying pamphlet will fully explain the conditions under which this second division is prosecuted.

These two forms of international exchange have hitherto been conducted entirely at the expense of the Smithsonian Institution. It has its own agents in Europe, several of whom receive a salary. It has paid the expenses of the delivery, as also that of the return of parcels sent through the same agent to institutions and persons in America, involving of late years a cost of about \$10,000 annually to the Smithsonian fund. This expense has become very onerous, and the proposition to divide it with foreign bureaus of exchange has been received with the greatest satisfaction. For many years Mr. Fredrick Müller, of Amsterdam, has been the Smithsonian agent for Belgium and the Netherlands, but the exchange bureau of Haarlem has now taken the matter out of his charge, so far as Holland is concerned; and we hail with great satisfaction the

prospect of a cordial and efficient relation of a similar character with your own bureau, by which the services of Mr. Müller for Belgium may in the future be dispensed with.

By a careful perusal of the rules herewith sent, you will observe that the Institution does not contemplate a miscellaneous exchange of unassigned or unaddressed books, but simply undertakes to maintain direct and intelligent relations between the different bodies and to deliver such parcels as bear an inscription of destination by the senders. In some instances it receives a number of copies of particular works unaddressed which it forwards at its own discretion to parties who appear to be suitable recipients. It is willing to transmit all such surplus copies intended for Belgium to your department for subsequent assignment. You can also in like manner send several copies of particular works for the same purpose; but we would profer that all other matter be specifically and formally addressed.

Your failure to receive an invoice of our previous sending is of less consequence, as a specific destination had been given the several packages. We did not propose to send a list of the contents of the packages, as these came to us already addressed. There will, however, be a list of the addresses themselves, and we shall forward a catalogue of the official publications contained in our transmissions to the Government of Belgium.

We have already sent you a copy of the list of Belgian institutions referred to in your letter of March 18, 1878, and shall be pleased to have any suggestions for its improvement.

In reply to your letter of the 29th of May, I beg to state that we are not yet in receipt of the box which you advised as sent to us on that date, and that unless we are informed of the route by which it was forwarded, and especially as to the port of departure and also the vessel on which it comes and its address in the United States, it will be impossible for us to obtain it.

Hereafter all boxes intended for this Institution should be addressed, *Smithsonian Institution, Washington, care of the Collector of Customs, New York*, and duplicate bills of lading sent, one to the collector and one to the Smithsonian Institution. In this way there will be no delay and the boxes will reach us after the shortest possible time. We shall also thus be able to pay the expenses of freight from your shipping point in Europe to Washington. We will in return deliver our packages in New York free of expense and have them shipped to Belgium. Should you have any particular channel of communication which you prefer, please advise us; otherwise we shall forward by Antwerp steamers from New York.

We will, with pleasure, act in behalf of the Belgian Geographical Society and the Royal Society of Botany, and endeavor to secure such exchanges as they may respectively desire,

As the Smithsonian Institution is already in possession of quite a full

series of transactions of Belgian scientific institutions, it will hardly be necessary for you to make any special effort to send this class of matter excepting in response to applications for desiderata.

The library of the Smithsonian Institution, constituting as it does a portion of the National Library of the United States in Washington, we have the satisfaction of knowing that by the combination of the results of the exchanges with learned societies and with foreign governments, we shall, in time, have under one roof, to a very important degree, that ideal public establishment referred to in your pamphlet, where the principal periodical and monographic works in science and literature are to be found.

I regret to say that the introduction to the bibliography of Belgium for the years 1875 to 1878 is not in our possession. If it reached us it has been mislaid, and we should be glad to have another copy.

Should the Numismatic Society of Belgium send its publication to the American Journal of Numismatics, in Philadelphia, through us, we would see that the desired return is made.

Referring to your letter of the 24th of January, 1879, I beg to renew the statement that the box of Belgian publications, mentioned as sent on the 25th of May, 1878, has not yet come to hand.

In the present communication you will find, I trust, the information previously asked for; and I hope that with the explanations herein made that the mutual relations of the Smithsonian Institution and of the Belgian Exchange Commission will be put on a satisfactory basis, and that hereafter there will be no interruption to a continued easy intercourse.

If we have not heretofore formally expressed ourselves to this effect, we now beg to state that you are at liberty to address parcels through the Smithsonian Institution in Washington to the Government of the United States, and to learned societies, and to men in any part of America. We will charge ourselves with the prompt delivery of such packages addressed to Canada, Mexico, Chili, Cuba, Brazil, &c.

I have the honor to be, very respectfully, your obedient servant,

SPENCER F. BAIRD,

*Secretary of Smithsonian Institution.*

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[The Brazilian Commission to the Smithsonian Institution.]

CENTRAL BRAZILIAN COMMISSION OF INTERNATIONAL EXCHANGES.

Office of the Secretary of State for Imperial Affairs,  
Rio de Janeiro, May 16, 1880.

To his excellency Prof. SPENCER F. BAIRD,

*Secretary of the Smithsonian Institution:*

ILLUSTRIOUS SIR: Mr. Xavier Charmes, attaché of the ministry of public instruction and fine arts of France, and chief of the department

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of international exchanges, having sent me, on the 20th of April last, at my request, the list of correspondents appointed by the various governments to take charge of international exchanges, gives me the information that you are the correspondent designated by your government for the above-mentioned service in your country, and I presume he has also informed you that the government of his Majesty the Emperor, my august sovereign, has founded (established) in the capital of Rio de Janeiro a central commission of international exchanges, naming me its president, and as associates, Abackarel Jeronymo Bandeira de Mello, chief of section of the general directory of statistics, and Guilherme Candido Bellegarde, chief of section of the central directory of the ministry of agriculture, commerce, and public works, as stated in the articles printed in the accompanying pamphlet, of which I have the honor of sending you three copies.

It remains, then, to inform you that the central Brazilian commission of international exchanges has been in operation since the 20th day of November last, and transacts its business in the third directory of the office of the secretary of state of imperial affairs, and that it will shortly send you the first remittance of our official publications, hoping that in return there will also be sent to it the official publication of your country.

I wish to congratulate you on account of the happy resolution taken by our respective governments, in the interest of the sciences and of the development and progress of civilization, to establish as a permanent institution the service of international exchanges, and I (very) especially congratulate myself on the opportunity thus afforded of opening relations with a gentleman so distinguished and illustrious as yourself.

Accept, eminent sir, the assurance of my highest esteem and consideration.

The president of the commission,

Dr. J. J. DE COMPOS DA COSTA DE MEDEIROS y ALBUQUERQUE.

[Inclosure.]

PROVISIONAL INSTRUCTIONS FOR THE GUIDANCE OF THE CENTRAL COMMISSION OF INTERNATIONAL EXCHANGES ESTABLISHED THIS DAY.

*Article I.* The central commission of international exchanges shall be installed in one of the rooms of the third department of the office of the secretary of the empire, and transact its business on such days and at such hours as will not interfere with the ordinary business of the office of the secretary.

*Art. II.* The commission is charged—

1. To correspond with similar institutions established in other countries, with respect to all matters within its competency.
2. To collect and transmit all information, scientific, literary, or concerning the arts, which may be solicited of them.
3. To have made, on behalf of the commissioners of other countries, the necessary examinations in the libraries, archives, book-stores, and other public and private establishments of the empire.

4. To collect together the documents intended for exchanges, and perform this in the way that shall be most beneficial to the empire.

5. To receive and distribute those which may be sent by foreign commissions.

6. To give all possible aid to scientific missions, both Brazilian and foreign.

7. To solicit from any authority or public department whatsoever everything that may be necessary for the fulfillment of the charge intrusted to it.

8. To appoint representatives (agents) in the provinces and give them the necessary instructions.

*Art. III.* The commission shall send to the minister and secretary of state of imperial affairs, before the 31st day of March of each year, a detailed report of the work accomplished and exchanges made during the preceding year, suggesting the changes it deems it advisable to make in the present instructions.

*Art. IV.* The materials necessary for carrying on (expediting) the business of the commission shall be furnished by the office of the secretary of state of imperial affairs.

Palace of Rio de Janeiro, November 13, 1879.

FRANCISCO MARIA SODIA PEREIRA.

[The State Department to the Smithsonian Institution.]

Department of State, Washington, June 17, 1880.

Prof. SPENCER F. BAIRD,

*Secretary of the Smithsonian Institution:*

SIR: I have the pleasure to inclose herein a copy of "regulations of the Russian commission for the international exchange of works of science and art," and a copy of a note from the chargé d'affaires *ad interim* of Russia, relating thereto, and to say that the department will be happy to communicate to the legation the purport of any observations which you may see proper to make in reference to the intelligence hereby conveyed.

I am, sir, your obedient servant,

JOHN HAY,

*Acting Secretary.*

[Inclosure No. 1.—Translation.]

Legation of Russia in the United States,  
Washington, May 19, 31, 1880.

His Excellency WILLIAM M. EVARTS,

*Secretary of State, &c., &c.:*

MR. SECRETARY OF STATE: The geographical congress which met at Paris in 1875, having recognized the necessity of organizing, in a uniform manner, in the various countries, the system of exchanging the various administrative, literary, or scientific publications of international interest, a resolution of the council of the empire, adopted April 10, 22, 1877, and sanctioned by His Majesty the Emperor, made provision for the establishment of a Russian commission of international exchange. The imperial ministry now informs me that this commission has just been

appointed under the presidency of Privy Councilor Bytchow, and is composed of delegates from the various branches of the government of the empire. It will be governed by special regulations, a copy of which I have the honor herewith to transmit.

I have been instructed to bring the foregoing to the notice of the Federal Government, and to inform your excellency that it will be the duty of this commission to enter into relations with the commission of the same kind existing in the United States, as regards all those matters which form the object of its mission.

Communications intended for the Russian commission should be addressed as follows: To the President of the Russian Commission of International Exchange, Imperial Public Library, St. Petersburg.

I avail myself of this occasion to beg you, Mr. Secretary of State, to be pleased to accept the assurance of my highest consideration and most profound respect.

G. WILLAMOV.

[Inclosure No. 2.—Translation.]

REGULATIONS OF THE RUSSIAN COMMISSION FOR THE INTERNATIONAL EXCHANGE OF  
WORKS OF SCIENCE AND ART.

The duties of the Russian commission shall be as follows:

1. It shall collect for the governments and learned institutions of foreign countries the publications intended for them, either as a gift or by way of exchange, and shall have charge of the shipment of such publications.

2. It shall send to the official and learned institutions of the empire of Russia the publications which are intended for them, either gratuitously or by way of exchange by foreign governments or institutions. Packages must be addressed to this commission.

3. It shall transmit to foreign commissions for the governments and learned institutions of foreign countries any information that may be asked of it and that it may be able to supply.

4. It shall furnish to the official or learned institutions of such foreign countries as may request it through their respective commissions information concerning the documents in the Russian archives and concerning the conditions on which a copy thereof will be furnished to them.

5. It shall have charge of the exchange of duplicates.

6. On the recommendation of foreign commissions it shall facilitate the accomplishment of their mission to scientific men visiting Russia, furnishing them, to this effect, with information, letters of recommendation, &c.

The Russian commission shall use its influence to the same end with foreign commissions in behalf of Russian scientists.

7. It shall act as a medium with foreign commissions for the obtaining of such information as may be required by the official and learned institutions of Russia.

8. It shall publish annually a catalogue of the official publications issued by the various departments of the government, the statistical committees, and the learned institutions and societies.

Within the limits of this programme the Russian commission will enter into correspondence with foreign commissions of the same character.

The commission shall present an annual report of its proceedings to the minister of public instruction.

[The Smithsonian Institution to the State Department.]

Smithsonian Institution, October 23, 1880.

Hon. WILLIAM M. EVARTS,

*Secretary of State:*

SIR: A geographical congress of nations, with delegates from the principal governments of the world, was held at Paris in the summer of 1875, and among the representatives was one from the United States of America.

One of the results of the deliberations of the congress was a recommendation of the adoption of a uniform system of exchanging the literary and scientific publications of all nations. This recommendation was reported to your predecessor in office, the Hon. Hamilton Fish, who requested that the Smithsonian Institution would act as the intermediary of the United States in carrying into effect the proposed system, as embodied in the recommendation of the Paris congress, as above referred to.

Under date of January 10, 1879, the Smithsonian Institution received the following communication from the Department of State in reference to the proposed international exchange system:

"You are already aware of the desire of this department to secure to the Smithsonian Institution the fullest liberty of action and the utmost enhancement of its utility without entailing any additional burden on its resources."

You are of course informed that a number of other governments represented at the congress of Paris have seconded the recommendation in question, and have already adopted special means, by establishing bureaus of international exchange, to carry its provisions into effect. Among these governments are France, Belgium, Holland, Switzerland, Russia, and Italy.

Recognizing the enlightened action of the Paris congress in recommending a system of interchange of scientific and literary thought between the different peoples of the world, and acting in accordance with the expressed wish of the Department of State, the Smithsonian Institution at once set about the inauguration of the proposed system on behalf of the Government of the United States.

It was originally presumed that by interlacing with the regular established systems of exchanges of the Institution so successfully conducted for more than a quarter of a century, the international system could be carried on at a very little outlay in addition to that required for the Smithsonian system. But this presumption did not prove to be a fact, the Institution finding, after two years' trial, that the expense attendant upon the execution of the request of the Department of State is far greater than was anticipated.

The Smithsonian Institution is therefore compelled to ask that an appropriation of \$7,000 be requested of Congress by the Department of

State, for the purpose of carrying into effect the recommendation of the Paris congress on a scale in keeping with the high position of the United States among civilized nations and commensurate with the reputation of the government for enlightened liberality in connection with the cause of general education.

I have the honor to be, very respectfully, your obedient servant,

SPENCER F. BAIRD,  
*Secretary of Smithsonian Institution.*

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[The State Department to the Smithsonian Institution.]

Department of State, Washington, October 30, 1880.

Prof. SPENCER F. BAIRD,

*Secretary of the Smithsonian Institution :*

SIR: I have the honor to acknowledge the receipt of your letter of the 23d instant, in relation to the expense of the work of conducting the exchange of the literary and scientific publications of all nations, recommended by the international geographical congress held at Paris in the summer of 1875, which work, at the instance of this department, the Smithsonian Institution undertook to carry on on behalf of the United States. You state, furthermore, that it was originally presumed that exchanges in question could be carried on in connection with the system already established, but that practically the additional work has been found to greatly increase the expense of conducting the exchanges, and that, therefore, the Smithsonian Institution is compelled to ask that an appropriation of \$7,000 be requested of Congress to defray the expenses of the exchanges recommended by the Paris congress, and undertaken on behalf of the United States by the Smithsonian Institution at the instance of this department.

In reply I have to say that, fully appreciating the importance of maintaining and extending this system of literary and scientific exchanges which has been so happily inaugurated, it will afford me much pleasure to ask the proper committees of Congress to favorably consider your request for an appropriation of \$7,000 for the purpose indicated in your letter.

I am, sir, your obedient servant,  
WM. M. EVARTS.

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[State Department to the Senate Committee on Appropriations.]

Department of State, Washington, January 31, 1881.

Hon. HENRY G. DAVIS,

*Chairman of the Committee on Appropriations, Senate:*

SIR: I have the honor to transmit herewith, for the information and consideration of your committee, a copy of a letter dated the 23d of



October last, from Prof. Spencer F. Baird, Secretary of the Smithsonian Institution, to this department, in relation to the expenses which have been imposed upon that institution by its having undertaken, at the instance of my predecessor, the Hon. Hamilton Fish, to carry out on behalf of this government the system of exchanging the literary and scientific publications of all nations which was adopted at an international conference held at Paris in the summer of 1875, at which this country was represented.

It now appears from the statements made in Professor Baird's letter that the expense of carrying out the exchanges in question is far greater than was anticipated, whereby an undue burden has been imposed upon the resources of the Smithsonian Institution; and Professor Baird therefore asks that an appropriation of \$7,000 may be made for the purpose of carrying out the recommendations of the Paris congress of 1875.

I may add that it is understood by this department that the exchanges of literary and scientific publications in question are now carried on at the expense of the several governments which were parties to the congress of 1875, except in the case of this government, which has imposed this important and useful work upon the Smithsonian Institution.

In view, therefore, of the reasons set forth by Professor Baird in a communication transmitted herewith, and in view of the great benefits which the government, institutions of learning, public libraries, and men of science are receiving from the system of the exchange of literary and scientific publications inaugurated by the congress of 1875 at Paris, I beg to recommend that the appropriation asked for, as above indicated, may be made.

I have the honor to be, sir, your obedient servant,  
WM. M. EVARTS.

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[The State Department to the Smithsonian Institution.]

Department of State, Washington, December 27, 1881.

Prof. SPENCER F. BAIRD,

*Secretary of the Smithsonian Institution:*

SIR: Referring to the reply of this department, of the 30th of October last, to your letter of the 23d of that month, in relation to the exchange of government and scientific publications with foreign countries, and referring also to the letter of this department to the Senate Committee on Appropriations, dated the 31st of January last, on the same subject, I now beg to request you to furnish this department with your views in relation to this matter, in form of a memorandum, to serve as the basis of a communication to Congress urging the appropriation of an amount sufficient to defray the expenses of international exchanges, and of so

organizing the work that it shall be done by the Smithsonian Institution, but under the Department of State, and with its official co-operation. This arrangement seems to be desirable in order that the American bureau of exchanges may be on the same footing as those in Europe, where this business is conducted under the supervision of the foreign officers of the various countries which have entered into the international agreement in relation to exchanges.

I may add that, owing to the want of sufficient funds to enable the Smithsonian Institution to carry out fully the system of exchanges, a large amount of labor and expense has been imposed upon this department in sending to various countries of Europe the publications of this government. The calls upon this department to perform services of this character are growing more and more numerous and more and more burdensome continually.

I am, sir, your obedient servant.  
J. C. BANCROFT DAVIS,  
*Acting Secretary.*

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[The Smithsonian Institution to the State Department.]

Smithsonian Institution, March 12, 1882.

Hon. F. T. FREELINGHUYSEN,  
*Secretary of State :*

SIR : The letter from the Department of State of December 27 last, in reference to the future prosecution by the Smithsonian Institution of its system of international exchanges under the direction of the State Department, was duly received, but the reply has been deferred until a statement of all the circumstances connected with the initiation and carrying on of this work to the present time could be prepared. This statement I now have the honor to submit for your consideration.

The statement in question is prefaced by an account of the attempts made prior to 1850 in the direction of a system of exchange, both in the United States and elsewhere, and it also presents points of the history of the concerted effort toward an international system started in Europe in 1875, and now in operation with fair prospects of success.

From the document referred to it will also be seen that the Smithsonian Institution has for many years carried on, single-handed and alone, so far as outside pecuniary aid is concerned, the most extensive system of exchange ever attempted. Originating in the transmission of the publications of the Institution, the Smithsonian exchange next included the publications of various learned societies of the United States; subsequently the exchanges of the government bureaus in Washington, and finally the international exchanges between the Congress of the United States and foreign governments. The cost to the Smithsonian fund of the maintenance of this system now amounts to about \$10,000 a year, an expenditure the Institution is entirely unable to continue, and

it becomes necessary, therefore, that operations in this department should hereafter be more confined to the immediate interests of the Institution, unless Congress shall vouchsafe its assistance.

Aid in connection with the exchange system is requested on the following grounds :

(1.) The expenses of the exchanges by the Smithsonian Institution of its own publications should in equity be paid by the United States Government, for the reason that the proceeds of these exchanges (now forming a library of about 100,000 volumes) are *all* deposited in the Congressional Library as soon as received.

(2.) The system enables the several departments and bureaus of the government to obtain valuable materials for their respective libraries by exchange of their publications for those of corresponding departments and bureaus of other governments, and which publications can be obtained *only through exchange*.

(3.) The work of the Institution for the benefit of other establishments in this country is *national* in its character, tending greatly to advance general science and popular education.

Your predecessor in office, realizing this drain upon the resources of the Smithsonian, requested Congress for an appropriation of \$7,000, which was the estimated cost of the work at the time; an allowance, however, of only \$3,000 was granted. The money was placed in charge of the Interior Department, this disposition of it being made presumably at the instance of the Department of State and as an indication of its preference to be relieved from further responsibility in the matter; and for this reason the Smithsonian Institution made direct application to Congress for an appropriation of \$5,000 for the coming fiscal year. This estimate, though entirely below the sum requisite for carrying on the work, was submitted as more likely to be allowed than a larger amount. I trust that if the Department of State is willing to continue its efforts in connection with the exchanges, it will ask for at least \$10,000 for the service. If it is desirable that the Smithsonian should also take charge of the government and other exchanges now passing through the State Department, a still larger sum will be required.

It will be entirely agreeable to the Smithsonian Institution to prosecute the exchange system under the general direction of the Department of State, and thereby secure the services of consuls or foreign ministers of the United States in those countries where national bureaus of exchange have not yet been established.

Commending the subject to your early and careful consideration,

I have the honor to be, &c.,

SPENCER F. BAIRD,

*Secretary of Smithsonian Institution.*

As the amount (\$3,000) appropriated by Congress in assistance of the Institution for the last year (1881) had been placed under the direction

of the Interior Department, the subject of the desired extension of government aid was naturally referred to the honorable Secretary of the Interior for his opinion. The following communication expresses his entire approval of the project:

[Mr. Kirkwood to Mr. Frelinghuysen.]

Department of the Interior, Washington, March 27, 1882.

SIR: I have the honor to acknowledge the receipt of your communication of the 24th instant touching the establishment of a bureau of international exchanges under the supervision of the Department of State, "the work of the bureau to be concentrated in the hands of the Smithsonian Institution, as the delegated agency of said department," and in reply to say that this department has long felt the need of some improved method of conducting international exchanges, by which the more certain and speedy delivery of packages transmitted may be secured. The chief difficulties encountered under the present system result, in the first place, from the very limited number of dispatch agencies employed by the Department of State, restricting transmission of documents, &c., received from other departments and offices to the three cities, London, Paris, and Hamburg; and, secondly, from the delay which often attends the dispatch of packages through the Smithsonian Institution, many months frequently elapsing between the delivery of a package to the Institution and its reception abroad. In addition, the present system involves the trouble of keeping accounts, and of the presentation and payment of bills for transportation, whether packages are transmitted by the Department of State or by the Smithsonian Institution.

It is understood that under the new system proposed by you these difficulties will be avoided; that not only will it unify our system of international exchanges, and "assimilate it with that of other countries," but also that greater dispatch and certainty of delivery will be attained.

It is furthermore presumed that the appropriation to be made for this purpose will be adequate to meet the necessities of all the departments and offices of the government, so that they will be relieved of all expense in the matter of transportation.

In view of the fact that the proposed arrangement seems to involve these advantages, I regard it as entitled to the approval of this department.

I have the honor to be, &c.,

S. J. KIRKWOOD.

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[Report of the Secretary of State to the President.]

To the PRESIDENT:

The Secretary of State has the honor to lay before the President, with a view to its transmission to Congress, a letter from the Secretary

of the Smithsonian Institution concerning the working of the present system of exchanges carried on by that Institution, and the practicality of the suggestion which has been made, that the scope of the Smithsonian Institution's bureau be enlarged so as to form an international bureau of governmental and scientific exchanges, under the supervision of the Department of State.

The Secretary of State has little to add to the very clear exposition made by Professor Baird of the rapid growth of the operations of the exchange bureau of the Smithsonian, and to his statements of the utility of still further extending them. He has been for some time convinced that an arrangement like that proposed would not only bring the system of diplomatic and literary exchanges of this country into harmonious relations with the like international exchange bureaus in other countries, but would greatly enlarge the beneficial results obtained under the present system of private enterprise, besides relieving the several executive departments of the labor and expense of effecting their own foreign exchanges, by concentrating the work in one properly equipped and competent bureau. His opinions in this regard are shared by other members of the government, as will be seen on perusal of the annexed letter from the Secretary of the Interior in response to an inquiry lately addressed to him. Should the President decide to recommend the latter to the consideration of Congress, the Secretary of State has the honor to advise that an appropriation of \$10,000 be asked for the coming fiscal year, in order that the proposed plan may have a fair chance to demonstrate its necessity and its benefits. It is probable that the scattered expenses under the present system of separate exchanges aggregate a larger amount than that which he suggests as the limit of a serviceable appropriation.

Respectfully submitted.

FRED'K T. FREELINGHUYSEN.

Department of State, Washington, April 11, 1882.

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[Recommendation by the President to Congress.]

To the HOUSE OF REPRESENTATIVES:

I transmit herewith, with commendation to the attention of Congress, a report of the Secretary of State and its accompanying papers concerning the proposed establishment of an International Bureau of Exchanges.

CHESTER A. ARTHUR.

EXECUTIVE MANSION,

Washington, April 14, 1882.

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